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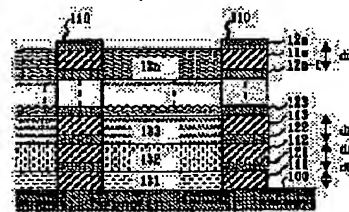
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## (54) THIN FILM FORMING METHOD, DISPLAY DEVICE, AND COLOR FILTER

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To reduce the cost needed for controlling affinity and to obtain a multi-layered thin film uniform in film thickness.

**SOLUTION:** A bank 110 having affinitive bank layers and nonaffinitive bank layers stacked by turns is formed by repeating more than once a process for forming the affinitive bank layers 111 to 11n of materials (inorganic material such as SiO<sub>2</sub>) affinitive with thin film material liquid and a process for forming nonaffinitive bank layers 121 to 12n of materials (organic material such as result) nonaffinitive with the thin film material liquid. Lastly, the thin film material liquid is charged between banks by an ink jet system and thermally treated to stack thin film layers 131 to 13n in order.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The process which is the thin film formation approach which fills up with thin film material liquid the field surrounded on the bank, and forms a thin film layer in it, and forms said bank in a bank forming face, The process which equips said bank with the process filled up with said thin film material liquid, and forms said bank in it By repeating the process which forms a compatibility bank layer with the ingredient in which compatibility is shown to said thin film material liquid, and the process which forms a non-compatibility bank layer with the ingredient which shows non-compatibility to said thin film material liquid on said compatibility bank layer once or more The thin film formation approach characterized by being that in which a compatibility bank layer and a non-compatibility bank layer form said bank by which the laminating was carried out by turns.

[Claim 2] The thin film formation approach according to claim 1 further equipped with the process which performs predetermined surface treatment to said bank and a bank forming face after the process which forms said bank.

[Claim 3] The process which performs said surface preparation is the thin film formation approach according to claim 2 of performing surface preparation under fixed conditions to which said non-compatibility bank layer becomes [ extent of the non-compatibility over said thin film material liquid ] higher compared with said compatibility bank layer.

[Claim 4] The process which performs said surface preparation is the thin film formation approach according to claim 3 of performing surface preparation under fixed conditions from which the compatibility over said thin film material liquid of said compatibility bank layer turns into below the compatibility over said thin film material liquid of the field surrounded on said bank further.

[Claim 5] Said surface treatment is the thin film formation approach according to claim 2 which is the plasma treatment which carries out a plasma exposure under the ambient atmosphere in which the gas which contained the fluorine or the fluorine compound in introductory gas was used, and oxygen was contained.

[Claim 6] Said fixed conditions are the thin film formation approach according to claim 3 on condition of there being more fluorine system compounds than oxygen.

[Claim 7] Said fixed conditions are the thin film formation approach according to claim 6 that the content of a fluorine system compound and the fluorine system compound to the total amount of oxygen is set up to 60% or more.

[Claim 8] The gas containing said fluorine is the thin film formation approach according to claim 5 of using the halogen gas of CF<sub>4</sub>, SF<sub>6</sub>, and CHF<sub>3</sub> grade.

[Claim 9] To said thin film material liquid, for a contact angle, said compatibility bank layer front face is said thin film formation approach according to claim 2 by which surface treatment is carried out so that it may become 30 or less degrees.

[Claim 10] To said thin film material liquid, for a contact angle, said non-compatibility bank layer front face is said thin film formation approach according to claim 2 by which surface treatment is carried out so that it may become 40 degrees or more.

[Claim 11] The compatibility bank layer formation process which forms the compatibility film with said

compatibility ingredient in the process which forms said bank, The non-compatibility bank layer formation process which forms a non-compatibility bank layer with a non-compatibility ingredient according to the formation field of said bank on said compatibility bank layer, The thin film formation approach according to claim 1 which resembles the removal process which etches and removes said compatibility bank layer of the field in which the non-compatibility bank layer concerned is not prepared by using said non-compatibility bank layer as a mask, and forms the compatibility bank layer of a lot, and a non-compatibility bank layer more.

[Claim 12] The process in which the process which forms said bank forms a compatibility bank layer with said compatibility ingredient, The process which etches the compatibility bank layer concerned according to the formation field of said bank lower layer, The process which covers said compatibility bank layer and forms a non-compatibility bank layer with a non-compatibility ingredient, The thin film formation approach according to claim 1 which resembles the process which etches the non-compatibility bank layer concerned according to the formation field of said bank upper layer, and forms the non-compatibility bank layer of a lot, and a non-compatibility bank layer more.

[Claim 13] The thin film formation approach given in either claim 11 which forms said non-compatibility bank layer with a photosensitive ingredient, or claim 12.

[Claim 14] It is the thin film formation approach according to claim 1 that said compatibility ingredient is an inorganic material and said non-compatibility ingredient is an organic material.

[Claim 15] Said non-compatibility ingredient is the thin film formation approach according to claim 1 which is either the organic compound which has polyimide, an amorphous silicon, polish recon, and a fluorine, or an insulating organic compound.

[Claim 16] Said compatibility ingredient is the thin film formation approach according to claim 1 which is either metals, such as aluminum and Ta, silicon oxide or a silicon nitride.

[Claim 17] Said thin film layer is the thin film formation approach according to claim 1 that the thin film layer of the lowest layer is set as the compatibility bank layer of the lowest layer of said bank, and the thickness of an abbreviation EQC.

[Claim 18] Said thin film layer is the thin film formation approach according to claim 1 set as the sum total of each thickness of the compatibility bank layer by which the laminating of each thin film layer by which a laminating is carried out above the lowest layer is carried out to the height to which said bank corresponds, and a non-compatibility bank layer, and the thickness of an abbreviation EQC.

[Claim 19] It is the thin film formation approach according to claim 1 that the thickness of said non-compatibility bank layer in the maximum upper layer is set as 500nm or less, and the thickness of said other non-compatibility bank layer is set as 100nm or less.

[Claim 20] The process which forms the process which forms said non-compatibility bank layer, and said compatibility bank layer is the thin film formation approach according to claim 1 which applies the predetermined ingredient melted by the solvent, forms each bank layer, and forms said non-compatibility bank layer by applying the ingredient of said non-compatibility bank layer before the solvent which had melted the ingredient of said compatibility bank layer is removed.

[Claim 21] It is the indicating equipment constituted by carrying out the laminating of the thin film layer which filled up with thin film material liquid the field surrounded on the bank, and was formed in it. Said bank The laminating of the compatibility bank layer which shows compatibility to said thin film material liquid, and the non-compatibility bank layer which shows non-compatibility to said thin film material liquid is carried out by turns. The display characterized by forming said thin film layer with the organic-semiconductor ingredient for the pixel electrode which consists of ITO etc. being prepared in the field surrounded on said bank, and forming a thin film light emitting device.

[Claim 22] Said compatibility bank layer or/and said non-compatibility bank layer are a display according to claim 21 by which surface treatment is carried out so that compatibility or non-compatibility may be shown, respectively.

[Claim 23] It is the color filter constituted by carrying out the laminating of the thin film layer which

filled up with thin film material liquid the field surrounded on the bank, and was formed in it. Said bank The laminating of the compatibility bank layer which shows compatibility to said thin film material liquid, and the non-compatibility bank layer which shows non-compatibility to said thin film material liquid is carried out by turns. It is the color filter characterized by forming a bank forming face with a transparence substrate, and forming said thin film layer with the coloring resin ingredient for said bank being a batch member into which a pixel field is divided, and giving color to said pixel.

[Claim 24] Said compatibility bank layer or/and said non-compatibility bank layer are a color filter according to claim 23 by which surface treatment is carried out so that compatibility or non-compatibility may be shown, respectively.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the thin film coating technology suitable for manufacture of the display and a color filter equipped with EL (electroluminescence) component or the LED (light emitting diode) component. In case a multilayer thin film layer is formed especially between batch members, it is related with an advantageous technique.

[0002]

[Description of the Prior Art] The technique of it being filled up with ingredients, such as organic-semiconductor film in a display and coloring resin in a color filter, using an ink jet method, and manufacturing the liquid crystal panel for color displays has been used. The batch member into which a pixel field is divided in order for the breathed-out thin film material liquid to prevent flowing into the next pixel, when filling up an ingredient with an ink jet method (henceforth "a bank") Moreover, the layer which constitutes a batch member is called "bank layer". It is necessary to prepare and to fill up with thin film material liquid the field surrounded by the batch member. The pixel field surrounded by the batch member is filled up with far large thin film material liquid compared with the volume after membrane formation. However, since a thing thin generally is required, a display cannot form a batch member highly indiscriminately. The behavior of the thin film material liquid filled up with what kind of wettability (compatibility) the field surrounded by the batch member or the batch member shows from this to thin film material liquid differs.

[0003] When a batch member is filled up with the ingredient of the amount which exceeds the height of a batch member as shown in drawing 9 (a) as it is compatibility to an ingredient, even if there is a batch member, an ingredient will flow into the pixel field which adjoins easily. Conversely, even if a batch member is filled up with the ingredient of the amount which exceeds the height of a batch member as shown in drawing 9 (b) as it is non-compatibility to an ingredient, an ingredient does not flow into the next pixel field with the surface tension of an ingredient. However, since an ingredient will be crawled by the side attachment wall of a batch member if this ingredient is heated and a solvent is evaporated, as

shown in drawing 9 (c), the thickness after membrane formation becomes it is thick and thin in the center section of the pixel field at a periphery. Now, an irregular color arises or dependability falls. Moreover, if a batch member is constituted from a non-compatibility member, the adhesion force with the ground plane of a batch member and a batch member will be weak, and a batch member will become easy to separate.

[0004] There was a technique which carries out surface treatment so that the upper part of a batch member may be made into non-compatibility and the other part may become compatibility as a Prior art which solves such a problem. For example, the technique of processing the upper part of a batch member into \*\* ink nature by UV irradiation, and processing into parent ink nature the field surrounded by the batch member is indicated by JP,9-203803,A and JP,9-230129,A. The former applies to the upper part of a batch member the layer which shows \*\* ink nature (non-compatibility), and the latter makes the crevice further surrounded by UV irradiation by the batch member parent ink nature (compatibility). The logical consideration is indicated by International Display Research Conference 1997 and pp 238-241. According to this technique, even if it fills up the height exceeding a batch member with an ingredient, as shown in drawing 10 (a), an ingredient is crawled with the film of non-compatibility and does not flow into the next pixel field. Moreover, since the side attachment wall of a batch member is equipped with compatibility, the thickness after membrane formation does not become thin around a pixel field.

[0005]

[Problem(s) to be Solved by the Invention] However, it was difficult to obtain a thin film layer that it is not clear how the compatibility in the side attachment wall of a batch member is set up also in the above-mentioned well-known technique, and flat. Although the purport which controls extent of compatibility by irradiating ultraviolet rays from both sides of a front flesh side was specified especially to JP,9-230129,A, about how the contact angle over extent, i.e., the thin film material liquid, of the compatibility of non-compatibility and compatibility is set up, respectively, it was unknown. For example, if non-compatibility is too high, as shown in drawing 9 (c), a thin film layer will become it is thin and thick in the center section by the periphery near a batch member. On the contrary, if compatibility is too high, as shown in drawing 10 (b), a thin film layer will become it is thick and thin in the center section by the periphery near a batch member.

[0006] Moreover, since the thin film layer came out further with the above-mentioned well-known technique and a certain thing was only assumed, it was completely unknown about the surface treatment which can form a flat thin film layer for every field coalescence layer which multilayers a thin film layer. temporary — much more — \*\* — if it becomes, whenever [ for which is boiled and the above-mentioned well-known technique is applied ] it forms further, surface treatment will be required, and many processes will be required very much.

[0007] The invention-in-this-application person discovered that the contact angle over ink changed greatly between the organic substance and an inorganic substance with mixing ratios of oxygen gas and fluorine gas, when plasma treatment was carried out by the gas of a fluorine system. And the invention-in-this-application person hit on an idea to control [ preparing the bank which carried out the laminating of a compatibility ingredient and the non-compatibility ingredient by turns, and ] compatibility by plasma treatment.

[0008] That is, the 1st technical problem of this invention is offering the thin film formation approach which can multilayer a thin film by carrying out the laminating of the bank with a different ingredient.

[0009] Moreover, the 2nd technical problem of this invention is controlling compatibility, without passing through many processes for compatibility control, reducing the cost which compatibility control takes to this, and enabling multilayering of a thin film by uniform thickness by managing surface treatment under fixed conditions.

[0010] The 3rd technical problem of this invention is offering the display multilayered by the thin film formation approach which makes multilayering possible. It is this performing image display which

unevenness's produces neither in brightness nor a color, and raising dependability.

[0011] The 4th technical problem of this invention is offering the color filter multilayered by the thin film formation approach which makes multilayering possible. It is that this performs image display which unevenness produces neither in brightness nor a color.

[0012]

[Means for Solving the Problem] Invention which solves the 1st technical problem of the above is the thin film formation approach which fills up with thin film material liquid the field surrounded on the bank, and forms a thin film layer in it, and is equipped with the process which forms a bank in a bank forming face, and the process which fills up a bank with thin film material liquid. And the process which forms a bank forms the bank by which the laminating was carried out by turns in the compatibility bank layer and the non-compatibility bank layer by repeating the process which forms a compatibility bank layer with a compatibility ingredient, and the process which forms a non-compatibility bank layer with a non-compatibility ingredient on a compatibility bank layer once or more.

[0013] The thing of the batch member which prepares a bank in order to divide the pixel of the display using for example, a non-compatibility semi-conductor thin film, or is prepared in order to divide the pixel field of a color filter is said here. The laminated structure of a bank may change and use the class of a non-compatibility ingredient or compatibility ingredient for every layer. The laminating of the thickness of each class may be changed and carried out for every layer. A bank forming face may be a field which prepares this bank, and may be drive substrates, such as a display, or may be transparenence substrates, such as a color filter, etc.

[0014] It is decided whether to be compatibility here or be non-compatibility by with what kind of property the thin film material liquid with which it is filled up is equipped. For example, if it is thin film material liquid with a hydrophilic property, the front face which has a polar group shows compatibility, and the front face which has a nonpolar group shows non-compatibility. Conversely, if it is thin film material liquid with oleophilic, the front face which has a polar group shows non-compatibility, and the front face which has a nonpolar group shows compatibility. for manufacture, it will boil variously as what thin film material liquid is used, it will change, and will apply. thin film material liquid — much more — \*\* — when whether it is alike and a hydrophilic property is shown or hydrophobicity is shown change, as a lower layer shows non-compatibility to this thin film material liquid among the bank layers of the bilayer prepared in the location corresponding to the thin film layer formed with that thin film material liquid and the upper layer shows compatibility, layer structure can be changed and it can apply. For example, when thin film material liquid has a hydrophilic property, an inorganic material is called compatibility ingredient and an organic material is called good non-compatibility ingredient. When thin film material liquid has hydrophobicity, an organic material is called compatibility ingredient and an inorganic material is called good non-compatibility ingredient.

[0015] For example, how to form the above-mentioned bank layer by spreading of an ingredient can be considered. That is, the process which forms the process which forms a non-compatibility bank layer, and said compatibility bank layer applies the predetermined ingredient melted by the solvent, and forms each bank layer. And before the solvent which had melted the ingredient of a compatibility bank layer is removed, a non-compatibility bank layer is formed by applying the ingredient of a non-compatibility bank layer.

[0016] Invention which solves the 2nd technical problem of the above is further equipped with the process which performs predetermined surface treatment to a bank and a bank forming face after the process which forms the above-mentioned bank. As surface treatment, the gas which contained the fluorine or the fluorine compound in introductory gas, for example is used, and the reduced pressure plasma treatment and atmospheric pressure plasma treatment which carry out a plasma exposure under a reduced pressure ambient atmosphere and an atmospheric pressure ambient atmosphere are performed. Performing plasma treatment in the gas containing a fluorine system compound and oxygen as fixed conditions is mentioned. Under these conditions, on the surface of an inorganic material, an

unreacted radical occurs by plasma discharge, an unreacted radical oxidizes by oxygen and polar groups, such as a carbonyl group and a hydroxyl group, occur. A polar group shows compatibility to the fluid containing polar molecules, such as water, and shows non-compatibility to the fluid containing a nonpolar molecule. The phenomenon in which a fluorine system compound molecule enters an organic material front face in parallel to the above reactions also in an organic bank layer front face is also produced.

[0017] When the content of a fluorine system compound and the fluorine system compound to the total amount of oxygen is set up to 60% or more when there are more especially fluorine system compounds than oxygen for example, since the mixing-ized phenomenon of a fluorine system compound prospers rather than the oxidation reaction by oxygen, by gas ambient atmosphere-ization with the excessive amount of a fluorine system compound, a front face is un-polarized by the mixing-ized phenomenon rather than the effect by oxidation reaction. Therefore, when a fluorine system compound carries out plasma treatment of the organic material on excessive conditions, non-compatibility is shown to the fluid containing a polar molecule, and compatibility comes to be shown to the fluid containing a nonpolar molecule. For example, the gas containing a fluorine uses the halogen gas of CF<sub>4</sub>, SF<sub>6</sub>, and CHF<sub>3</sub> grade. If surface preparation is performed under these conditions, the compatibility of that front face will be adjusted so that the contact angles over thin film material liquid may differ greatly between a non-compatibility bank layer and a compatibility bank layer. Thereby, to thin film material liquid, surface treatment for example, of the compatibility bank layer front face is carried out so that a contact angle may become 30 or less degrees. Moreover, to thin film material liquid, surface treatment of the non-compatibility bank layer front face is carried out so that a contact angle may become 40 degrees or more.

[0018] The process which performs the above-mentioned surface preparation performs surface preparation under fixed conditions to which a non-compatibility bank layer becomes [ extent of the non-compatibility over thin film material liquid ] higher compared with a compatibility ingredient. The process which furthermore performs surface preparation performs surface preparation under fixed conditions from which the compatibility over the thin film material liquid of a compatibility bank layer turns into below the compatibility over the thin film material liquid of the field surrounded on a bank.

[0019] The compatibility bank layer formation process which forms the compatibility film with a compatibility ingredient in the process which forms the above-mentioned bank, for example, The non-compatibility bank layer formation process which forms a non-compatibility bank layer with a non-compatibility ingredient according to the formation field of a bank on a compatibility bank layer, The removal process which etches and removes the compatibility bank layer of the field in which the non-compatibility bank layer concerned is not prepared is resembled by using a non-compatibility bank layer as a mask, and the compatibility bank layer of a lot and a non-compatibility bank layer are formed more. Moreover, the process which forms a bank looks like [ the process which forms a compatibility bank layer with a compatibility ingredient; the process which etch the compatibility bank layer concerned according to the formation field of a bank lower layer, the process which cover a compatibility bank layer and form a non-compatibility bank layer with a non-compatibility ingredient, and the process which etch the non-compatibility bank layer concerned according to the formation field of the bank upper layer ], and forms the non-compatibility bank layer of a lot, and a non-compatibility bank layer more. In addition, after piling up all or almost all the compatibility bank layer, and a non-compatibility bank layer, without carrying out etching to a bank configuration each time, two or more sets of compatibility bank layers and a non-compatibility bank layer may be etched at a stretch collectively.

[0020] Here, for example, a non-compatibility ingredient is either the organic compound which has polyimide, an amorphous silicon, polish recon, and a fluorine, or an insulating organic compound (photosensitive ingredient). A compatibility ingredient is either metals, such as aluminum and Ta, silicon oxide or a silicon nitride.

[0021] Preferably, the thin film layer is set as the compatibility bank layer of the lowest layer of a bank



of the thin film layer of the lowest layer, and the thickness of an abbreviation EQC. Moreover, each thin film layer by which a laminating is carried out above the lowest layer is set as the sum total of each thickness of the compatibility bank layer by which the laminating is carried out to the height to which a bank corresponds, and a non-compatibility bank layer, and the thickness of an abbreviation EQC. The thin film material liquid with which it filled up changes the contact configuration of the wall surface and oil level with the compatibility of the wall surface of a bank. It is in the inclination for the thickness of a thin film to decrease in it since thin film material liquid is crawled by the inclination which thin film material liquid sticks with a wall surface, and the thickness of a thin film increases in the contact surface with a non-compatibility bank layer, in the contact surface with a compatibility bank layer. Although the volume decreases by heat-treatment etc., if the thin film material liquid with which it filled up so much is adjusted so that the oil level of the thin film material liquid after heat-treatment termination may be located in the boundary of a non-compatibility bank layer and a compatibility bank layer, the property of a non-compatibility bank layer and a compatibility bank layer is balanced, the oil level of thin film material liquid will become perpendicular to a bank wall surface, and, on the whole, it will become flat. For example, the thickness of 500nm or less and the other non-compatibility bank layer is set as 100nm or less for the thickness of the non-compatibility bank layer in the maximum upper layer.

[0022] Invention which solves the 3rd technical problem of the above is an indicating equipment constituted by carrying out the laminating of the thin film layer which filled up with thin film material liquid the field surrounded on the bank, and was formed in it. Said bank The compatibility bank layer formed with the ingredient in which compatibility is shown to said thin film material liquid, The laminating of the non-compatibility bank layer formed with the ingredient in which non-compatibility is shown to said thin film material liquid is carried out by turns. It is the display characterized by forming said thin film layer with the organic-semiconductor ingredient for the pixel electrode which consists of ITO etc. being prepared in the field surrounded on said bank, and forming a thin film light emitting device.

[0023] Invention which solves the 4th technical problem of the above is a color filter constituted by carrying out the laminating of the thin film layer which filled up with thin film material liquid the field surrounded on the bank, and was formed in it. Said bank The compatibility bank layer formed with the ingredient in which compatibility is shown to said thin film material liquid, The laminating of the non-compatibility bank layer formed with the ingredient in which non-compatibility is shown to said thin film material liquid is carried out by turns. It is the color filter characterized by forming a bank forming face with a transparence substrate, and forming said thin film layer with the coloring resin ingredient for said bank being a batch member into which a pixel field is divided, and giving color to said pixel.

[0024] In addition, in the above-mentioned indicating equipment or a color filter, surface treatment of a compatibility bank layer or/and the non-compatibility bank layer is carried out so that compatibility or non-compatibility may be shown, respectively.

[0025]

[Embodiment of the Invention] Next, the gestalt of suitable operation of this invention is explained with reference to a drawing.

(Operation gestalt 1) The operation gestalt 1 of this invention is related with the thin film formation approach of using one layer as a mask of the layer of another side among two or more kinds of layers which constitute a bank. The sectional view of the thin film laminated structure formed in drawing 1 by the thin film formation approach of this invention is shown. This laminated structure is usable for all the applications that use the multilayered thin film. For example, it is usable to the EL element using an organic-semiconductor thin film, LED, a color filter, etc. The laminated structure of drawing 1 is the structure in the case of using what has a hydrophilic property as thin film material liquid. With thin film material liquid with a hydrophilic property, compatibility becomes [ compatibility ] high low at an organic material at the inorganic material by which surface treatment was carried out (non-compatibility).

[0026] As shown in drawing 1, this laminated structure establishes bank 110 in the bank forming face 100, and is constituted. Even if a bank forming face is a transparence substrate used for a color filter



even if it is the drive substrate with which the thin film transistor (TFT:Thin Film Transistor) used for an indicating equipment was formed, it is good anything. If it is the purpose which fills up with a fluid the field surrounded on a batch member slack bank, and forms a thin film in it, there will be no limitation in the structure of a bank forming face. However, it is desirable that it is the good ingredient of the compatibility bank layer 111 and adhesion which forms the lowest layer of bank 110. It is desirable in order that consisting of especially inorganic materials may acquire suitable compatibility by next surface treatment. If ITO, silicon, etc. which are a transparent electrode if it is a display are a color filter, it consists of glass, a quartz, etc. and high adhesion with a compatibility bank layer can be maintained. [0027] Bank 110 carries out the laminating of the compatibility bank layers 111-11n (n is the natural number) and the non-compatibility bank layers 121-12n by turns, and is constituted. Surface treatment of the compatibility bank layers 111-11n is carried out so that it may have the thin film material liquid which forms the thin film layers 131-13n of the location corresponding to the layer, and fixed compatibility. It may be desirable that it is the good ingredient of the bank forming face 100, the non-compatibility bank layers 121-12n, and adhesion as a compatibility bank layers [ 111-11n ] ingredient, and the ingredient may have insulation, a property as a semi-conductor, and conductive any. For example, it is possible to use metals, such as general aluminum, Ta, etc. as an insulator layer as compatibility bank layers 111-11n, silicon oxide (SiO<sub>2</sub>), a silicon nitride (SiN<sub>x</sub>), etc. It is not necessary to use the same ingredient for each compatibility bank layer. each — it is not necessary to unify all the compatibility bank layers into the same \*\* y wax that the thin film material liquid and compatibility of thin film layer 13x which are established corresponding to compatibility bank layer 11x (x is the natural number of arbitration) should just be a good ingredient

[0028] Surface treatment of the non-compatibility bank layers 121-12n is carried out so that the thin film material liquid and the non-compatibility which form the thin film layers 131-13n of the location corresponding to the layer may be \*(ed). It may be desirable that it is the good ingredient of the compatibility bank layers 111-11n and adhesion as a non-compatibility bank layers [ 121-12n ] ingredient, and the ingredient may have insulation, a property as a semi-conductor, and conductive any. For example, it is possible to use an organic compound or an insulating organic compound etc. which has polyimide, an amorphous silicon, polish recon, and a fluorine as non-compatibility bank layers 121-12n. It is not necessary to use the same ingredient for each \*\*\*\*\* bank layer. the case where surface preparation is carried out — each — if it is the ingredient with which the thin film material liquid and compatibility of thin film layer 13x prepared corresponding to compatibility bank layer 11x (x is the natural number of arbitration) become good, an ingredient is changed and a laminating is possible. For example, when applying this laminated structure to a color filter, the 12n of the maximum upper layers may be constituted from a black matrix, and an electric shielding function may be made to make it serve a double purpose. In order to form as a covered member, metals and oxide, such as chromium, and a black resist ingredient are used.

[0029] The thickness of each bank layer is set up as follows. When the lowest layer is the compatibility bank layer 131, it sets up so that the thickness d0 of the compatibility bank layer 131 may turn into thickness of the thin film layer 131 formed corresponding to this layer to an abbreviation EQC. the layer of a moreover — the non-compatibility bank layer 11 — it sets up so that it may become an abbreviation EQC in the thickness of x+1 and thin film layer 13x+1 in which the thickness dx adding compatibility bank layer 12x is formed corresponding to these layers. for example, the thickness d1 in which the thickness of the thin film layer 132 totaled the non-compatibility bank layer 121 and the compatibility bank layer 112 — abbreviation — it is equal. the thickness dn in which the thickness of 13n of thin film layers totaled 12n [ of non-compatibility bank layers ] - 1 and 11n of compatibility bank layers — abbreviation — it is equal. These setup is important in order to form a flat thin film layer.

[0030] In addition, the above-mentioned laminated structure is applied when thin film material liquid consists of molecules with a polar group. When thin film material liquid consists of molecules without a polar group, it is used replacing the ingredient of a non-compatibility bank layer and a compatibility bank

layer. moreover, a thin film layer — much more — \*\* — what is necessary is just to choose the ingredient of a bank layer, as a lower layer shows non-compatibility to this thin film material liquid among the bank layers of the bilayer in the location where it fills up with each thin film material liquid and the upper layer shows compatibility when it consists of molecules which are alike and have a polar group or consists of molecules without a polar group

[0031] The thin film layers 131–13n consist of ingredients with which each was equipped with the target property. For example, when applying this laminated structure to a display, the organic–semiconductor thin film material liquid of arbitration is filled up with and formed in each thin film layer. Two or more laminatings of the organic–semiconductor thin film material liquid which emits light in primary color are carried out for every thin film layer, or the laminating of the ingredient of an electron hole transportation layer or an electronic transportation layer is filled up with and carried out if needed. For example, when applying this laminated structure to a color filter, the laminating of the resin with which refractive indexes differ is filled up with and carried out to each thin film layer. Such a laminating diaphragm structure serves as an optical interference filter, and only the light of specific wavelength is penetrated and it becomes the configuration which can offer the good color of selectivity. A black matrix may be applied to the maximum upper layer of a bank. \*\*\*\* yoke chromic oxide, a \*\*\*\* black resist, etc. are applied. This layer may be a non-compatibility layer and combination, or a non-compatibility layer may be prepared separately. As mentioned above, each thin film layers [ 131–13n ] thickness spreads abbreviation etc., and is set as the thickness which totaled the non-compatibility bank layer currently formed in the location corresponding to the thin film layer, and the compatibility bank layer.

[0032] (Operation of a laminated structure) According to the layer structure of the above-mentioned bank, the equipment with which the thickness of each class carried out the laminating of the uniform thin film layer can be offered. If the bank 110 is manufactured in the above-mentioned configuration, flattening of the thickness of a thin film layer will be carried out. That is, restoration of thin film material liquid changes the contact configuration of the oil level of thin film material liquid to the wall surface with the compatibility of the wall surface of a bank. In the contact surface with a compatibility bank layer, it becomes the inclination for the thickness of a thin film to decrease in it since thin film material liquid is crawled by the inclination which thin film material liquid sticks with a wall surface, and the thickness of a thin film increases in the contact surface with a non-compatibility bank layer. Although the volume decreases by heat-treatment etc., if the thin film material liquid with which it filled up so much is adjusted so that the oil level of the thin film material liquid after heat-treatment termination may be located in the boundary of a non-compatibility bank layer and a compatibility bank layer, the property of a non-compatibility bank layer and a compatibility bank layer is balanced, the oil level of thin film material liquid will become perpendicular to a bank wall surface, and, on the whole, it will become flat.

[0033] With the equipment which used this laminated structure, fixed effectiveness is done so from a thin film layer being flat. In passing a current to inter-electrode as the thickness of each thin film layer is uniform, and forming in a luminescence mold display device, inter-electrode current density becomes fixed, the homogeneity of luminescence can be improved, and since the current concentration to a specific part is avoidable, dependability improves. Moreover, since electric field are not built over a thin part with the component with which an electrical potential difference is impressed to inter-electrode, dependability can improve and a life can be prolonged. Furthermore, a color and brightness are equalized. Moreover, when applying to a color filter, the homogeneity of a color can be raised and failures, such as a color omission, can be prevented.

[0034] (The manufacture approach) The thin film formation approach for next obtaining this laminated structure is explained with reference to drawing 2 and the production process sectional view of drawing 3.

Bank formation process ( drawing 2 (a) – (d)) : A bank formation process is a process which carries out the laminating of the compatibility bank layers 111–11n and the non-compatibility bank layers 121–12n to the bank forming face 100, and forms bank 110. The compatibility bank layer 111 is first formed in the

bank forming face 100 whole surface ( drawing 2 (a)). although the formation approach changes with ingredients — PECVD (Plasma Enhanced Chemical Vapor Deposition) — law and CVD (Chemical Vapor Deposition) — there are law, vacuum deposition, and a spatter and various kinds of coat approaches (a spin coat, a spray code, a roll coat, a die coat, DIP coat). For example, with this operation gestalt, SiO<sub>2</sub> film by SOG (Spin onGlass) is formed with a spin coat method. The thickness of the compatibility bank layer 111 of the lowest layer is doubled with the thickness of the thin film layer 131. Subsequently, the non-compatibility bank layer 121 is formed according to a bank configuration ( drawing 2 (b)). The formation approach of a non-compatibility bank layer forms an organic material in the whole surface by the above-mentioned approach first. In using the usual photolithography method, a mask is given according to a bank configuration, and it exposes, develops and removes a resist, and it etches at the end and the organic material of parts other than a mask is removed. When using print processes, an organic material is directly applied to a bank configuration by the approach of arbitration, such as an intaglio, the Taira version, and letterpress. The thickness of the non-compatibility bank layer 121 makes the function which crawls the thin film material liquid with which it fills up behind the thickness of extent which does so enough. However, it adjusts in the range in which the thickness doubled with the following compatibility bank layer 112 put on this layer becomes an abbreviation EQC in the thin film layer 132. Subsequently, the inorganic material film is etched by using the non-compatibility bank layer 121 as a resist mask ( drawing 2 (c)). A non-compatibility bank layer is an organic material, and it is because it can act as a resist mask. Subsequently, SOG is again applied to the whole surface as an inorganic material like drawing 2 (a) ( drawing 2 (d)). The thickness of an inorganic material makes the thin film material liquid with which it fills up behind, and the function to stick the thickness of extent which does so enough. However, it adjusts in the range in which the thickness doubled with the non-compatibility bank layer 121 put on the bottom of this layer becomes an abbreviation EQC in the thin film layer 132. The bank is repeated, repeating the process of drawing 2 (b) – (d) henceforth. The laminating of the maximum upper layer is carried out so that 12n of non-compatibility bank layers may be arranged. Supposing the maximum upper layer does not have non-compatibility, it is because the thin film material liquid with which it filled up overcomes bank 110 and flows out.

[0035] The structure which consists of a crevice 101 surrounded on the bank 110 as shown in drawing 2 (e) according to the above-mentioned process, and the bank is formed. The bank of multilayer structure where the laminating of the layer which shows the layer which shows compatibility, and non-compatibility according to this structure was carried out by turns is formed. What is necessary is just to shift to the process which carries out sequential restoration of the thin film material liquid in a crevice 101 next, as shown in drawing 3 (b). However, surface treatment which adjusts extent of the compatibility over the thin film material liquid of the bank forming face 100 and each class of bank 110 as shown below here will be performed.

[0036] Surface-preparation process ( drawing 3 (a) ) : A surface-preparation process is a process which performs plasma treatment under fixed conditions and adjusts the compatibility over the thin film material liquid of the bank forming face 100 and each class of bank 110. In the plasma treatment of this invention, the gas which contains a fluorine as introductory gas is used. It may be the reduced pressure plasma treatment under a reduced pressure ambient atmosphere, or you may be the atmospheric pressure plasma treatment under an atmospheric pressure ambient atmosphere. It is desirable that the oxygen of a constant rate is contained in reactant gas. As a fluorine system compound, the halogen gas of CF<sub>4</sub>, SF<sub>6</sub>, and CHF<sub>3</sub> grade etc. is used.

[0037] \*\*\*\*\* in which a front face tends to get wet to the fluid of arbitration, such as thin film material liquid, — being hard — or — that is, it can know whether compatibility is shown or non-compatibility is shown by measuring the contact angle over the fluid on the front face of an ingredient. When plasma treatment of an organic material and the inorganic material is carried out to drawing 4 , drawing which measured how a contact angle would change with the mixing ratio of a fluorine compound and oxygen is shown. A contact angle is a contact angle over drainage system ink (ink which can be thinned with

water). CF<sub>4</sub> is used for this drawing as a fluorine system compound, polyimide is illustrated as an organic material and it has illustrated SiO<sub>2</sub> and ITO (Indium-Tin-Oxide) as an inorganic material. It is thought that the inclination which is similar according to whether it is organic or it is inorganic about other ingredients is seen. As shown in drawing 4, under the ambient atmosphere where oxygen is excessive, an organic material and an inorganic material do not have a big difference in extent of a contact angle. However, if a fluorine system compound makes it excessive, the contact angle of an organic material will become large (it becomes non-compatibility when thin film material liquid is compatibility). On the other hand, change of the contact angle of an inorganic material is small. If oxygen is contained in reactant gas, a polar group will generate an inorganic material and an organic material by the oxidation by oxygen. However, in order for a fluorine compound molecule to enter into an organic material that a fluorine system compound is excessive, it is thought that the effect of a polar group decreases relatively. Therefore, while a fluorine system compound controls by excessive conditions compared with oxygen, by carrying out plasma treatment, bank 110 and bank forming face 100 front face can be set as a desired contact angle (compatibility) according to drawing 4. especially — best [ of drawing 4 ] — it is desirable to use a mixing ratio (CF<sub>4</sub>/CF<sub>4</sub>+O<sub>2</sub>=75%-90%), in order that the difference of both contact angle may consider as max. However, if an important point is for the difference of the contact angle between polyimide, and SOG and ITO to set up greatly, and there is about 70% or more of CF<sub>4</sub> according to drawing 4 in order to attain this purpose, it will be thought that it is enough. For example, to thin film material liquid, surface treatment of the compatibility bank layer front face is carried out so that a contact angle may become 30 or less degrees. Moreover, to thin film material liquid, surface treatment of the non-compatibility bank layer front face is carried out so that a contact angle may become 40 degrees or more.

[0038] Reduced pressure plasma treatment or atmospheric pressure plasma treatment is performed so that a fluorine system compound may be made into introductory gas with this operation gestalt and oxygen may be mixed at a fixed rate from the above fact. For example, in the plasma treatment of a capacity-coupling mold, the substrate which has the bank forming face 100 for the above-mentioned gas on sink one electrode in a reaction chamber is laid, and electric field are added from a power source. various a well-known approach, for example, direct current anodizing, a RF method, an inductive-coupling form, a capacity-coupling form, microwave methods, methods of adding electric field and a field to \*\*, etc. can be looked like [ how to add the energy to a reaction chamber ], and it can apply to it.

[0039] For example, in the bank forming face 100 (base of a crevice 101), when SiO<sub>2</sub> and a non-compatibility bank layer are formed for transparent electrodes, such as ITO, and a compatibility bank layer with polyimide, surface preparation of whenever [ to thin film material liquid 130 / affinity ] is carried out by the above-mentioned surface preparation so that it may become the sequence of a bank forming face >= compatibility bank layer > non-compatibility bank layer.

[0040] Film formation process ( drawing 3 (b) - (d) ): A film formation process is a process which carries out sequential restoration of the thin film material liquid, and carries out the laminating of the thin film layer to the crevice 101 surrounded on the bank 110. As thin film material liquid 130, when applying to a display, an organic-semiconductor ingredient, the ingredient which doped the electron hole supply element as an electron hole transportation layer, the ingredient which doped the electronic supply element as an electronic transportation layer are used. It applies coloring resin etc., in applying to a color filter.

[0041] The thickness of the layer currently formed in the location corresponding to the thin film layer concerned adjusts the amount filled up with each thin film material liquid. In the thin film layer 131 of the lowest layer, it is adjusted to an amount from which the thickness after a solvent component evaporates from thin film material liquid by heat-treatment becomes the compatibility bank layer 111 and an abbreviation EQC (broken line of drawing 3 (b)). in the thin film layers 132-13n above it, the thickness after a solvent component evaporates from thin film material liquid by heat-treatment is prepared in the corresponding location -- un--- the doubled thickness of compatibility bank layer 12x and compatibility

bank layer 11x+1 — abbreviation — it is adjusted so that it may become equivalent ( drawing 3 (c), (d)).

[0042] It is desirable to be based on an ink jet method as an approach filled up with thin film material liquid. It is because it can fill up with small equipment which can fill up a fluid into the location of arbitration with the amount of arbitration, and is used for a home printer according to the ink jet method. If thin film material liquid is filled up with an ink jet method, thin film material liquid will be heated and a solvent component will be removed. It requires that viscosity is usually several pc or less making it breathe out from an ink jet type recording head. For this reason, there is much discharge quantity compared with the thickness of a final required thin film layer. Just behind the regurgitation, thin film material liquid touches the compatibility bank layer arranged above final thickness. A solvent component evaporates by heat-treatment, the volume takes for decreasing, and thin film material liquid lowers the oil level, though an oil level is lengthened by the bank wall surface. Since thin film material liquid will be crawled if this oil level starts a non-compatibility bank layer, the point of contact of thin film material liquid and a wall surface moves to the compatibility bank layer under one step. Thus, if the oil level falls gradually and the volume of thin film material liquid decreases to near the thickness of a final thin film layer, the point of contact of the oil level of thin film material liquid and a wall surface will move even to the boundary of the compatibility bank layer and the non-compatibility bank layer of the right above of it which are located in the bottom in the bank layer which is in contact with the thin film material liquid. In the volume of the thin film material liquid after heat-treatment having been filled up with the thin film material liquid, the fill of thin film material liquid spreads \*\* to the height which totaled the non-compatibility bank layer and compatibility bank layer which are located in the bottom, abbreviation, etc., and is set up. For this reason, after an oil level moves to the boundary of the compatibility bank layer and the non-compatibility bank layer of the right above of it which are located in the bottom, an oil level does not fall any more. a volume decrease — the thickness of the center section of thin film material liquid — gradually — falling — all the parts from a contact part with a bank wall surface to a center section — it is the phase which was and became equal thickness, and a thin film layer is solidified and it completes.

[0043] For example, in the thin film layer 131 of the lowest layer, as shown in drawing 3 (b), the regurgitation of the thin film material liquid 130 is carried out to the crevice 101 surrounded on the bank 110 from the ink jet type recording head 102 to the location of a broken line. And it heat-treats and is made the flat thin film layer 131. In the thin film layer 132 on it, as shown in drawing 3 (c), the regurgitation of the thin film material liquid 130 is carried out from the ink jet type recording head 102 to the location of a broken line on the thin film layer 131. And it heat-treats and is made the flat thin film layer 132. These processings are repeated until 13n of thin film layers is formed.

[0044] In addition, as an ink jet method, you may be the approach of carrying out the regurgitation by gassing by heat also in a piezo jet method. The nozzle and the piezo electric crystal component are equipped with and constituted from a piezo jet method by the pressure room. If an electrical potential difference is impressed to the piezo electric crystal component with which the fluid is filled up into the pressure room, a volume change will arise in a pressure room and the drop of a fluid will be breathed out from a nozzle. By the method which carries out the regurgitation by gassing, the heating element is prepared in the pressure room which passes to a nozzle. A heating element is made to generate heat, the fluid of the nozzle neighborhood is boiled, air bubbles are generated, and the regurgitation of the fluid is carried out by the cubical expansion. A piezo jet method is desirable at a point without deterioration of the fluid by heating.

[0045] As described above, according to this operation gestalt 1, each thin film layer can be formed evenly. Moreover, by performing plasma treatment on the conditions which oxygen is mixing in a fluorine system compound, the non-compatibility on the front face of a bank made with the organic material to thin film material liquid and the compatibility of the bank front face made with the inorganic material and a bank forming face can be adjusted. And the contact angle which shows the degree of compatibility according to a property as shown in drawing 4 can be set up easily. That is, the bank itself can control

the compatibility of a bank and a bank forming face certainly, without passing through many processes like before for compatibility control, maintaining high adhesion with a bank forming face. It can prevent by this that thin film material liquid flows out across a bank, the yield can be raised, and a manufacturing cost can be decreased.

[0046] (Operation gestalt 2) The operation gestalt 2 of this invention carries out the laminating of the bank by different approach from the above-mentioned operation gestalt. The production process sectional view of this operation gestalt is shown in drawing 5. This operation gestalt is applied to all applications that fill up with a predetermined fluid the field which established the bank in the bank forming face in the configuration of arbitration, and was divided like the above-mentioned operation gestalt 1 on the bank. For example, when filling up coloring resin into a pixel field with the case where an organic-semiconductor ingredient is filled up with the display device using an organic-semiconductor thin film into a pixel field, or a color filter, it can apply.

[0047] Lower layer film formation process ( drawing 5 (a) – (c)) : A lower layer film formation process is a process which forms the compatibility bank layer 111 in the bank forming face 100. An inorganic material is first applied by the same approach as the above-mentioned operation gestalt 1 ( drawing 5 (a)). Subsequently, according to a bank configuration, a mask 140 is formed on an inorganic material layer ( drawing 5 (b)). Subsequently, an inorganic material layer is etched, it leaves the field in which the mask 140 was laid, and an inorganic material is removed ( drawing 5 (c)). The etching approach is chosen according to the property of an ingredient. In the case of the inorganic material of SiO<sub>2</sub> grade, the wet etching which used etching reagents other than dry etching, such as fluoric acid (HF), is applicable. The compatibility bank layer 111 of the lowest layer is formed above. Next, an organic material is applied by the same approach as the above-mentioned operation gestalt ( drawing 5 (d)). Subsequently, according to a bank configuration, a mask 142 is formed on an organic material layer ( drawing 5 (e)). Subsequently, an organic material layer is etched, it leaves the field in which the mask 141 was laid, and an organic material is removed ( drawing 5 (f)). The etching approach is chosen according to the property of an ingredient. In the case of organic materials, such as polyimide, the wet etching which used other etching reagents (NMP (N-methyl pyrrolidone)) of dry etching is applicable. The non-compatibility bank layer 121 is formed above. It is possible independently to change a bank configuration [ in / since it can etch / for not a thing but each upper layer which etches a compatibility bank layer by using a non-compatibility bank layer as a mask like the above-mentioned operation gestalt 1 with this operation gestalt / a compatibility bank layer ], and the bank configuration in a non-compatibility bank layer. For example, width of face of a bank is narrowed as it goes to the upper layer from a lower layer, and it can form in a stairway configuration or a false taper configuration. Thus, if a bank is formed, when it can suppose that restoration of the thin film material liquid used as a thin film layer is easy, and a bank is overcome and it forms a circuit pattern, an open circuit of the wiring can be prevented. By choosing the configuration of this bank lower layer as a suitable thing, a thin film layer can be suitably prepared now. The above process ( drawing 5 (a) – (f) is repeated the required number of laminating times (for example, n times), and bank 110 is formed like drawing 5 (g).) Since it is the same as that of the above-mentioned operation gestalt 1 about a surface treatment process and a thin film layer formation process, explanation is omitted.

[0048] Since according to this operation gestalt 2 the same effectiveness as the operation gestalt 1 is done so and also the configuration of each class of a bank can be changed as described above, the configuration of the optimal thin film layer can be set up according to an application device.

[0049]

[Example] The layer structure of the example which applied the above-mentioned operation gestalt is shown. Drawing 6 is the layer structure sectional view of the example which applied this invention to the color filter. As shown in drawing 6, a substrate 200 is filled up with the batch member 210, it fills up with coloring resin 231–233 the pixel field 201 which forms in the shape of a grid and is surrounded by the batch member 210 seen from a flat surface, and this color filter is constituted. A substrate 200 is



equivalent to the bank forming face of this invention, and coloring resin and adhesion consist of a good transparent ingredient, glass, a quartz, resin, etc. The bank member 210 is equivalent to a bank of this invention, and the black matrix layer 221 is formed as a compatibility bank layer as the resin layer (or inorganic insulator layer layer) 211 and a non-compatibility bank layer. The resin layer (or insulator layer layer) 211 operates resin orthopedically in a bank configuration, and is constituted. The black matrix layer 221 applies the organic insulating material containing an inorganic material or carbon, and is constituted. The coloring resin layers 231 (red), 232 (green), and 233 (blue) are equivalent to the thin film layer of this invention, are filled up with the resin with which the color of primary colors, such as red, green, and blue, was mixed every pixel field 201, and are constituted.

[0050] According to the above-mentioned configuration, as the resin layer (or insulator layer layer) 211 has coloring resin and compatibility, surface preparation is carried out, and surface treatment is carried out as the black matrix layer 221 shows coloring resin and non-compatibility. For this reason, if it is filled up with coloring resin with an ink jet method and heat-treats, the coloring resin layers 231-233 will be formed evenly. For this reason, image display which unevenness produces neither in brightness nor a color can be performed.

[0051] Drawing 7 is the layer structure sectional view of the example which applied this invention to the organic-semiconductor light emitting device of a display. As shown in drawing 7, this organic-semiconductor light emitting device forms bank 310 in the drive substrate 300 at transparent electrode 341 pan, forms the organic-semiconductor layer 331 in the crevice 301 surrounded on the bank 310, and is constituted. The whole is covered and the metal electrode 351 is formed. The laminating of TFT, wiring, the insulator layer, etc. is carried out to a multilayer, and the drive substrate 300 is constituted possible [ impression of an electrical potential difference ] between the transparent electrode 341 and the metal electrode 351. A transparent electrode 341 carries out the laminating of 0.05 micrometers – about 0.2 micrometers of the ITO(s) etc., is constituted, and is constituted possible [ transparency of the light from the organic-semiconductor layer 331, and the reflected light by the metal electrode 351 ]. The bank 310 is constituted by a lower layer 311 and the upper layer 321. A lower layer 311 consists of inorganic materials which have compatibility in an organic-semiconductor ingredient, and is constituted by silicon oxide, silicon nitride, etc. which are formed by the CVD method, a spatter or the various coat methods, etc. The upper layer 321 consists of organic materials which show non-compatibility to an organic-semiconductor ingredient, and is constituted by an organic compound or an insulating organic compound etc. which has polyimide, an amorphous silicon, polish recon, and a fluorine. The organic-semiconductor layer 331 carries out the laminating of 0.05 micrometers – about 0.2 micrometers of ingredients which emit light by impression of electric field, for example, the well-known ingredients, such as polyphenylene vinylene (PPV), and is constituted. A metal electrode 351 carries out the laminating of 0.1 micrometers – about 1.0 micrometers (aluminum-Li) of the aluminum lithiums, and is constituted.

[0052] Since according to the above-mentioned configuration surface treatment is carried out, and surface treatment is carried out as the upper layer 321 shows the organic-semiconductor layer 331 and non-compatibility as a lower layer 311 has the organic-semiconductor layer 331 and compatibility, if an organic-semiconductor ingredient is filled up with and heat-treated by the ink jet method, the organic-semiconductor layer 331 will be formed evenly. For this reason, image display which produces neither unevenness nor a color omission in brightness or a color can be performed. Moreover, an electrode short circuit can be prevented, the dependability of the whole display can be raised, and a life can be prolonged.

[0053] Drawing 8 is the layer structure sectional view of other examples which applied this invention to the organic-semiconductor light emitting device of a display. As shown in drawing 8, this organic-semiconductor light emitting device forms bank 410 in the drive substrate 400 at transparent electrode 441 pan, carries out the laminating of the electron hole transportation layer 431 and the organic-semiconductor layer 432 to the crevice 401 surrounded on the bank 410, and is constituted. The whole is covered and the metal electrode 451 is formed. About between the drive substrate 400, a transparent



electrode 441, the organic-semiconductor layer 432, and a metal electrode 451, it is the same as that of the example of above-mentioned drawing 7. Bank 410 carries out the laminating of the compatibility layers 411 and 412 and the non-compatibility layers 421 and 422 by turns, and is constituted. The compatibility layer 411 consists of inorganic materials which have compatibility in an electron hole transportation ingredient or an organic-semiconductor ingredient, and is constituted by silicon oxide, silicon nitride, etc. which are formed by the CVD method, a spatter or the various coat methods, etc. The non-compatibility layer 421 consists of organic materials which show non-compatibility to an organic-semiconductor ingredient, and is constituted by an organic compound or an insulating organic compound etc. which has polyimide or an amorphous silicon, polish recon, and a fluorine. The electron hole transportation layer 431 is constituted by ITO in which the ingredient which can carry an electron hole from the transparent electrode 441 which is an anode plate to the organic-semiconductor layer 432, for example, an electron hole supply element, was made to mix.

[0054] According to the above-mentioned configuration, as the compatibility layer 411 has the electron hole transportation layer 431 and compatibility, surface treatment is carried out, and surface treatment is carried out as the compatibility layer 412 has the organic-semiconductor layer 432 and compatibility. Moreover, surface treatment is carried out as the non-compatibility layer 421 shows the electron hole transportation layer 431, the organic-semiconductor layer 432, and non-compatibility. For this reason, if it is filled up with the electron hole transportation layer 431 and the organic-semiconductor layer 432 with an ink jet method and they are heat-treated, each will be formed evenly. For this reason, image display which produces neither unevenness nor a color omission in brightness or a color can be performed. Moreover, an electrode short circuit can be prevented, the dependability of the whole display can be raised, and a life can be prolonged.

[0055] in addition, the structure of a color filter or organic electroluminescence devices can be boiled not only in the above but variously; and can be changed. For example, in organic electroluminescence devices, the laminating of an electronic transportation layer or other organic-semiconductor layers may be carried out further.

[0056] (Other modifications) it is not limited to the above-mentioned operation gestalt, and in the range of the meaning of this invention, many things are boiled, it changes and this invention can be applied the formation approach of a bank using a compatibility ingredient, a non-compatibility ingredient, and them is not depended above, but is deformable to versatility. By arranging by turns the layer from which extent of compatibility differs, the main point of this invention is in the point which is distorted and forms a thin film layer that there is nothing. For example, a bank is formed with the ingredient for bank formation in which thick-film-izing is possible, and also a bank of this invention may be formed by applying to a bank front face the ingredient in which compatibility is shown, and the ingredient in which non-compatibility is shown. For example, the diethylene-glycol methylethyl ether ( $C_2H_5OCH_2CH_2CH_2OCH_2CH_2OCH_3$ ) and 2-perfluoro octyl ethyl acrylate ( $FCF_2$ )  $8CH_2CH_2 OOOCH=CH_2$  show non-compatibility to the thin film material liquid which has a polar-group molecule by itself.

[0057] Moreover, the above-mentioned surface treatment is not restricted to plasma treatment, and if it is the surface treatment approach that different compatibility under the same surface treatment conditions is processible as shown in drawing 4, it is applicable. It is because the main point of this invention is in the point that surface treatment adjusts compatibility. Therefore, the ingredient which sets up compatibility is not restricted between an inorganic material and an organic material, and if it shows the property of the compatibility shown between specific ingredients at drawing 4, it can apply the surface treatment of this invention between the specific ingredient.

[0058] moreover, the ingredient with which the above-mentioned bank is affinitive and the ingredient in which non-compatibility is shown — a laminating — carrying out — \*\* — it does not stop. For example, after constituting the configuration of this invention from a single member, forming so that the field which shows compatibility to thin film material liquid, and the field which shows non-compatibility may become by turns can also attain it. For example, a bank ingredient is constituted from a compatibility

ingredient and it is possible to apply a non-compatibility ingredient in the shape of stripes. Paraffin besides the above-mentioned example etc. is mentioned to a non-compatibility ingredient. Moreover, the field which constitutes a bank ingredient from a non-compatibility ingredient, carries out UV irradiation to the shape of stripes, and is affinitive is made, or it decharges in the shape of stripes, a charge is used, and it is \*\*\*\*\* in applying a compatibility ingredient \*\*\*\*. Furthermore a metal thin film is formed in the whole bank ingredient, and if immersed in the sulfur compound with the substituent which shows a sulfur compound with an affinitive substituent, and non-compatibility sequentially from the lower layer, a compatibility field and a non-compatibility field can be formed in the shape of stripes with the single molecular association-ized film.

[0059]

[Effect of the Invention] According to the thin film formation approach of this invention, with a different ingredient, it can be distorted and the thin film layer formed can be formed by carrying out the laminating of the bank that there is nothing. Thereby, the engine performance and dependability of a device can be raised sharply. Moreover, according to the thin film formation approach of this invention, compatibility can be controlled possible [ multilayering of a thin film ] by performing surface treatment under fixed conditions, without passing through many processes for compatibility control. The cost which compatibility control takes can be reduced by this, and multilayering of a thin film can be enabled by uniform thickness. Since it is multilayered by the thin film formation approach which makes multilayering possible according to the display of this invention, a laminating is possible in the thin film layer of uniform thickness. Thereby, image display which produces neither unevenness nor a color omission in brightness or a color can be performed. Moreover, an electrode short circuit can be prevented, dependability can be raised and a life can be prolonged. Since it is multilayered by the thin film formation approach which makes multilayering possible according to the color filter of this invention, a laminating is possible in the thin film layer of uniform thickness. Thereby, image display which unevenness produces neither in brightness nor a color can be performed.

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[Translation done.]

**\* NOTICES \***

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.\*\*\* shows the word which can not be translated.

3.In the drawings, any words are not translated.

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**DESCRIPTION OF DRAWINGS.**

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[Brief Description of the Drawings]

[Drawing 1] It is the sectional view of the thin film laminated structure concerning the operation gestalt 1 of this invention.

[Drawing 2] It is the production process sectional view of the thin film formation approach concerning the operation gestalt 1 of this invention.

[Drawing 3] It is the production process sectional view (continuation) of the thin film formation approach concerning the operation gestalt 1 of this invention.

[Drawing 4] It is a property Fig. explaining the relation between the mixing ratio of the fluorine system compound and oxygen concerning the principle of the surface treatment of this invention, and a contact angle.

[Drawing 5] It is the production process sectional view of the thin film formation approach concerning the operation gestalt 2 of this invention.

[Drawing 6] It is the sectional view of the example which applied this invention to the color filter.

[Drawing 7] It is the sectional view of the example which applied this invention to the organic-semiconductor light emitting device of a display.

[Drawing 8] It is the sectional view of other examples which applied this invention to the organic-semiconductor light emitting device of a display.

[Drawing 9] It is the explanatory view of the trouble in the conventional bank formation.

[Drawing 10] It is the explanatory view of the trouble in the conventional bank formation.

[Description of Notations]

100,200 300,400 Bank forming face (substrate)

101, 201, 301, 401 Crevice

110, 210, 310, 410 Bank

111-11n, 11x Compatibility bank layer

121-12n, 12x Non-compatibility bank layer

130 Thin Film Material Liquid

131-13n, 13x Thin film layer

102 Ink Jet Type Recording Head

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[Translation done.]



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## 【特許請求の範囲】

【請求項1】 バンクで囲まれた領域に薄膜材料液を充填して薄膜層を形成する薄膜形成方法であって、バンク形成面に前記バンクを形成する工程と、前記バンクに前記薄膜材料液を充填する工程と、を備え、

前記バンクを形成する工程は、前記薄膜材料液に対し親和性を示す材料で親和性バンク層を形成する工程と、前記親和性バンク層上に前記薄膜材料液に対し非親和性を示す材料で非親和性バンク層を形成する工程と、を一回以上繰り返すことにより、親和性バンク層と非親和性バンク層とが交互に積層された前記バンクを形成するものであることを特徴とする薄膜形成方法。

【請求項2】 前記バンクを形成する工程の後に、前記バンクおよびバンク形成面に対して所定の表面処理を行う工程をさらに備える請求項1に記載の薄膜形成方法。

【請求項3】 前記表面処理を行う工程は、前記非親和性バンク層が前記親和性バンク層に比べて前記薄膜材料液に対する非親和性の程度がより高くなるような一定条件下で表面処理を行う請求項2に記載の薄膜形成方法。

【請求項4】 前記表面処理を行う工程は、さらに前記親和性バンク層の前記薄膜材料液に対する親和性が前記バンクで囲まれる領域の前記薄膜材料液に対する親和性以下になるような一定条件下で表面処理を行う請求項3に記載の薄膜形成方法。

【請求項5】 前記表面処理は、導入ガスにフッ素またはフッ素化合物を含んだガスを使用し、酸素が含まれた雰囲気下でプラズマ照射をするプラズマ処理である請求項2に記載の薄膜形成方法。

【請求項6】 前記一定条件は、フッ素系化合物が酸素よりも多いことを条件とする請求項3に記載の薄膜形成方法。

【請求項7】 前記一定条件は、フッ素系化合物および酸素の総量に対するフッ素系化合物の含有量が60%以上に設定されている請求項6に記載の薄膜形成方法。

【請求項8】 前記フッ素を含んだガスは $CF_4$ 、 $SF_6$ 、 $CHF_3$ 等のハロゲンガスを用いる請求項5に記載の薄膜形成方法。

【請求項9】 前記親和性バンク層表面が前記薄膜材料液に対し接触角が30度以下になるように前記表面処理される請求項2に記載の薄膜形成方法。

【請求項10】 前記非親和性バンク層表面が前記薄膜材料液に対し接触角が40度以上になるように前記表面処理される請求項2に記載の薄膜形成方法。

【請求項11】 前記バンクを形成する工程では、前記親和性材料で親和性膜を形成する親和性バンク層形成工程と、前記親和性バンク層上で前記バンクの形成領域に合わせて非親和性材料で非親和性バンク層を形成する非親和性バンク層形成工程と、前記非親和性バンク層をマスクとして当該非親和性バンク層が設けられていない領

域の前記親和性バンク層をエッチングして除去する除去工程と、により一組の親和性バンク層および非親和性バンク層を形成する請求項1に記載の薄膜形成方法。

【請求項12】 前記バンクを形成する工程は、前記親和性材料で親和性バンク層を形成する工程と、当該親和性バンク層を前記バンク下層の形成領域に合わせてエッチングする工程と、前記親和性バンク層を覆って非親和性材料で非親和性バンク層を形成する工程と、当該非親和性バンク層を前記バンク上層の形成領域に合わせてエッチングする工程と、により一組の非親和性バンク層および非親和性バンク層を形成する請求項1に記載の薄膜形成方法。

【請求項13】 前記非親和性バンク層を感光性材料で形成する請求項11または請求項12のいずれかに記載の薄膜形成方法。

【請求項14】 前記親和性材料は無機材料であり前記非親和性材料は有機材料である請求項1に記載の薄膜形成方法。

【請求項15】 前記非親和性材料は、ポリイミド、アモルファスシリコン、ポリシリコン、フッ素を有する有機化合物または絶縁有機化合物のいずれかである請求項1に記載の薄膜形成方法。

【請求項16】 前記親和性材料は、Al、Ta等の金属、シリコン酸化膜またはシリコン窒化膜のいずれかである請求項1に記載の薄膜形成方法。

【請求項17】 前記薄膜層は、その最下層の薄膜層が前記バンクの最下層の親和性バンク層と略同等の厚みに設定されている請求項1に記載の薄膜形成方法。

【請求項18】 前記薄膜層は、その最下層より上に積層される各薄膜層が前記バンクの対応する高さに積層されている親和性バンク層と非親和性バンク層のそれぞれの厚みの合計と略同等の厚みに設定されている請求項1に記載の薄膜形成方法。

【請求項19】 最上層にある前記非親和性バンク層の厚みは5.00nm以下に設定され、それ以外の前記非親和性バンク層の厚みは100nm以下に設定されている請求項1に記載の薄膜形成方法。

【請求項20】 前記非親和性バンク層を形成する工程および前記親和性バンク層を形成する工程は、溶剤に溶かされた所定の材料を塗布してそれぞれのバンク層を形成するものであり、前記親和性バンク層の材料を溶かしていた溶剤が除去される前に前記非親和性バンク層の材料を塗布することにより前記非親和性バンク層を形成する請求項1に記載の薄膜形成方法。

【請求項21】 バンクで囲まれた領域に薄膜材料液を充填して形成された薄膜層を積層して構成される表示装置であって、

前記バンクは、前記薄膜材料液に対し親和性を示す親和性バンク層と、前記薄膜材料液に対し非親和性を示す非親和性バンク層とが交互に積層され、

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前記バンクで囲まれる領域にはITO等からなる画素電極が設けられ、薄膜発光素子を形成するための有機半導体材料により前記薄膜層が形成されていることを特徴とする表示装置。

【請求項22】 前記親和性バンク層または／および前記非親和性バンク層は、それぞれ親和性または非親和性を示すように表面処理されたものである請求項21に記載の表示装置。

【請求項23】 バンクで囲まれた領域に薄膜材料液を充填して形成された薄膜層を積層して構成されるカラーフィルタであって、前記バンクは、前記薄膜材料液に対し親和性を示す親和性バンク層と、前記薄膜材料液に対し非親和性を示す非親和性バンク層とが交互に積層され、バンク形成面は透明基板で形成され、前記バンクは画素領域を仕切る仕切部材であって、前記画素に色彩を付与するための着色樹脂材料により前記薄膜層が形成されていることを特徴とするカラーフィルタ。

【請求項24】 前記親和性バンク層または／および前記非親和性バンク層は、それぞれ親和性または非親和性を示すように表面処理されたものである請求項23に記載のカラーフィルタ。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、EL（エレクトロルミネッセンス）素子またはLED（発光ダイオード）素子などを備えた表示装置やカラーフィルタの製造に適した薄膜形成技術に係わる。特に仕切部材間に多層の薄膜層を形成する際に有利な技術に関する。

【0002】

【従来の技術】 インクジェット方式を使用して表示装置における有機半導体膜やカラーフィルタにおける着色樹脂等の材料を充填してカラー表示用液晶パネルを製造する技術が用いられてきた。インクジェット方式で材料を充填する場合、吐出された薄膜材料液が隣の画素に流出することを防止するためには、画素領域を仕切る仕切部材（以下「バンク」ともいう。また仕切部材を構成する層を「バンク層」という。）を設け、仕切部材に囲まれる領域に薄膜材料液を充填する必要がある。仕切部材で囲まれた画素領域には成膜後の体積に比べてはるかに大きい薄膜材料液が充填される。しかし表示装置は一般に薄いことが要求されるため、仕切部材をやたらに高く形成することができない。このことから仕切部材や仕切部材で囲まれた領域が、薄膜材料液に対してどのような濡れ性（親和性）を示すかで充填された薄膜材料液の挙動が異なる。

【0003】 仕切部材が材料に対し親和性であると、図9（a）に示すように仕切部材の高さを超える量の材料を充填した場合に、仕切部材があっても材料は容易に隣接する画素領域に流出してしまう。逆に仕切部材が材料

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に対し非親和性であると、図9（b）に示すように仕切部材の高さを超える量の材料を充填しても材料の表面張力により隣の画素領域に材料が流れ出すことはない。しかしこの材料を加熱して溶媒を蒸発させると仕切部材の側壁で材料がはじかれるため、図9（c）に示すように成膜後の厚みが画素領域の中央部で厚く周辺部で薄くなる。これでは色むらが生じたり信頼性が低下したりする。また仕切部材を非親和性部材で構成すると、仕切部材と仕切部材の接地面との密着力が弱く、仕切部材が剥がれやすくなる。

【0004】 このような問題を解決する従来の技術として、仕切部材の上部を非親和性にしそれ以外の部分が親和性になるよう表面加工する技術があった。例えば特開平9-203803号公報や特開平9-230129号公報には、仕切部材の上部を紫外線照射により撥インク性に加工し、仕切部材で囲まれた領域を親インク性に加工する技術が開示されている。前者は撥インク性（非親和性）を示す層を仕切部材の上部に塗布するものであり、後者はさらに紫外線照射により仕切部材で囲まれた凹部を親インク性（親和性）にするものである。その論理的考察については、International Display Research Conference 1997, pp 238-241に記載されている。この技術によれば、仕切部材を超える高さに材料を充填しても、図10（a）に示すように材料が非親和性の膜によってはじかれ隣の画素領域に流れ出すことがない。また仕切部材の側壁が親和性を備えるため、成膜後の厚みが画素領域の周辺で薄くなることもない。

【0005】

【発明が解決しようとする課題】 しかしながら、上記公知技術においても仕切部材の側壁における親和性をどのように設定するのかが明らかでなく、平坦な薄膜層を得ることが困難であった。特に特開平9-230129号公報には紫外線を表裏の両面から照射することで親和性の程度を制御する旨が規定されているが、非親和性と親和性との親和性の程度、すなわち薄膜材料液に対する接触角をそれぞれどのように設定するかについては不明であった。例えば非親和性が高すぎると図9（c）に示すように仕切部材に近い周辺部で薄膜層が薄くかつ中央部で厚くなる。逆に、親和性が高すぎると図10（b）に示すように仕切部材に近い周辺部で薄膜層が厚くかつ中央部で薄くなる。

【0006】 また上記公知技術では薄膜層が一層であることを想定しているだけなので、薄膜層を多層化する場合一層ごとに平坦な薄膜層を形成可能な表面処理について全く不明であった。仮に一層ごとに上記公知技術を用するならば、一層形成するたびに表面処理を要求され、非常に多数の工程が要求されることになる。

【0007】 本願発明者はフッ素系のガスによりプラズマ処理をすると、酸素ガスとフッ素ガスとの混合比によって有機物と無機物との間でインクに対する接触角が大

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大きく異なることを発見した。そして本願発明者は、親和性材料と非親和性材料とを交互に積層したバンクを設けること、およびプラズマ処理により親和性を制御することに想到した。

【0008】すなわち本発明の第1の課題は、異なる材料でバンクを積層することにより、薄膜を多層化することができる薄膜形成方法を提供することである。

【0009】また本発明の第2の課題は、表面処理を一定条件下で管理することにより、親和性制御のために多数の工程を経ることなく親和性を制御し、これにより親和性制御に要するコストを削減し、均一な膜厚で薄膜の多層化を可能とすることである。

【0010】本発明の第3の課題は、多層化を可能とする薄膜形成方法によって多層化された表示装置を提供することである。これにより、明るさや色にむらが生じない画像表示を行い、信頼性を向上させることである。

【0011】本発明の第4の課題は、多層化を可能とする薄膜形成方法によって多層化されたカラーフィルタを提供することである。これにより、明るさや色にむらが生じない画像表示を行うことである。

【0012】

【課題を解決するための手段】上記第1の課題を解決する発明は、バンクで囲まれた領域に薄膜材料液を充填して薄膜層を形成する薄膜形成方法であって、バンク形成面にバンクを形成する工程と、バンクに薄膜材料液を充填する工程と、を備える。そしてバンクを形成する工程は、親和性材料で親和性バンク層を形成する工程と、親和性バンク層上に非親和性材料で非親和性バンク層を形成する工程と、を一回以上繰り返すことにより、親和性バンク層と非親和性バンク層とを交互に積層されたバンクを形成するものである。

【0013】ここでバンクとは、例えば非親和性半導体薄膜素子を利用した表示装置の画素を仕切るために設けたり、カラーフィルタの画素領域を仕切るために設けたりする仕切部材のことをいう。バンクの積層構造は層ごとに非親和性材料や親和性材料の種類を変えて用いてもよい。各層の厚みは層ごとに変更して積層してもよい。バンク形成面とはこのバンクを設ける面のことで、表示装置等の駆動基板であってもカラーフィルタ等の透明基板等であってもよい。

【0014】ここで親和性であるか非親和性であるかは、充填する薄膜材料液がどのような性質を備えているかで決まる。例えば親水性のある薄膜材料液であれば、極性基を有する表面が親和性を示し、非極性基を有する表面が非親和性を示す。逆に親油性のある薄膜材料液であれば、極性基を有する表面が非親和性を示し、非極性基を有する表面が親和性を示す。薄膜材料液を何にするかは、製造対象によって種々に変更して適用することになる。薄膜材料液が一層ごとに親水性を示すか疎水性を示すかが変わる場合には、その薄膜材料液で形成される

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薄膜層に対応する位置に設けられる二層のバンク層のうち、この薄膜材料液に対して下層が非親和性を示し上層が親和性を示すように、層構造を変更して適用可能である。例えば薄膜材料液が親水性を有する場合に、親和性材料とは無機材料をいい非親和性材料とは有機材料をいう。薄膜材料液が疎水性を有する場合には、親和性材料とは有機材料をいい非親和性材料とは無機材料をいう。

【0015】例えば上記バンク層を材料の塗布により形成する方法が考えられる。すなわち、非親和性バンク層を形成する工程および前記親和性バンク層を形成する工程は、溶剤に溶かされた所定の材料を塗布してそれぞれのバンク層を形成するものである。そして親和性バンク層の材料を溶かしていた溶剤が除去される前に非親和性バンク層の材料を塗布することにより非親和性バンク層を形成する。

【0016】上記第2の課題を解決する発明は、上記バンクを形成する工程の後に、バンクおよびバンク形成面に対して所定の表面処理を行う工程をさらに備える。表面処理としては、例えば導入ガスにフッ素またはフッ素化合物を含んだガスを使用し、減圧雰囲気下や大気圧雰囲気下でプラズマ照射をする減圧プラズマ処理や大気圧プラズマ処理を行う。一定条件としては、フッ素系化合物および酸素を含んだガス中でプラズマ処理を行うことが挙げられる。この条件下では無機材料の表面にはプラズマ放電により未反応基が発生し、酸素により未反応基が酸化されてカルボニル基や水酸基等の極性基が発生する。極性基は水等の極性分子を含んだ流動体に対して親和性を示し、非極性分子を含んだ流動体に対し非親和性を示す。有機バンク層表面においても上記のような反応と並行してフッ素系化合物分子が有機材料表面に入り込む現象も生ずる。

【0017】特にフッ素系化合物が酸素よりも多い場合、例えばフッ素系化合物および酸素の総量に対するフッ素系化合物の含有量が60%以上に設定されていると、フッ素系化合物の量が過多のガス雰囲気化では酸素による酸化反応よりも、フッ素系化合物の混入化現象の方が盛んになるため、酸化反応による影響よりも混入化現象により表面が非極性化される。したがって有機材料をフッ素系化合物が過多の条件でプラズマ処理すると、極性分子を含んだ流動体に対して非親和性を示し、非極性分子を含んだ流動体に対して親和性を示すようになる。例えばフッ素を含んだガスはCF<sub>4</sub>、SF<sub>6</sub>、CHF<sub>3</sub>等のハロゲンガスをを用いる。この条件下で表面処理を施すと非親和性バンク層と親和性バンク層との間で薄膜材料液に対する接触角が大きく異なるようにその表面の親和性が調整される。これにより、例えば親和性バンク層表面が薄膜材料液に対し接触角が30度以下になるように表面処理される。また非親和性バンク層表面が薄膜材料液に対し接触角が40度以上になるように表面処理される。



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【0018】上記表面処理を行う工程は、非親和性バンク層が親和性材料に比べて薄膜材料液に対する非親和性の程度がより高くなるような一定条件下で表面処理を行う。さらに表面処理を行う工程は、親和性バンク層の薄膜材料液に対する親和性がバンクで囲まれる領域の薄膜材料液に対する親和性以下になるような一定条件下で表面処理を行う。

【0019】上記バンクを形成する工程では、例えば、親和性材料で親和性膜を形成する親和性バンク層形成工程と、親和性バンク層上でバンクの形成領域に合わせて非親和性材料で非親和性バンク層を形成する非親和性バンク層形成工程と、非親和性バンク層をマスクとして当該非親和性バンク層が設けられていない領域の親和性バンク層をエッチングして除去する除去工程と、により一組の親和性バンク層および非親和性バンク層を形成する。また、バンクを形成する工程は、親和性材料で親和性バンク層を形成する工程と、当該親和性バンク層をバンク下層の形成領域に合わせてエッチングする工程と、親和性バンク層を覆って非親和性材料で非親和性バンク層を形成する工程と、当該非親和性バンク層をバンク上層の形成領域に合わせてエッチングする工程と、により一組の非親和性バンク層および非親和性バンク層を形成する。なお、バンク形状へのエッチングを毎回せずに総てあるいはほとんどの親和性バンク層と非親和性バンク層とを重ねた後、複数組の親和性バンク層および非親和性バンク層をまとめて一気にエッチングしてしまってもよい。

【0020】ここで、例えば非親和性材料は、ポリイミド、アモルファスシリコン、ポリシリコン、フッ素を有する有機化合物または絶縁有機化合物（感光性材料）のいずれかである。親和性材料は、Al、Ta等の金属、シリコン酸化膜またはシリコン窒化膜のいずれかである。

【0021】好ましくは、薄膜層はその最下層の薄膜層がバンクの最下層の親和性バンク層と略同等の厚みに設定されている。またその最下層より上に積層される各薄膜層がバンクの対応する高さに積層されている親和性バンク層と非親和性バンク層のそれぞれの厚みの合計と略同等の厚みに設定されている。充填された薄膜材料液はバンクの壁面の親和性によってその壁面と液面の接触形状が変わる。親和性バンク層との接触面では薄膜材料液が壁面と密着し薄膜の厚みが増加する傾向に、非親和性バンク層との接触面では薄膜材料液がはじかれるため薄膜の厚みが減少する傾向にある。多量に充填された薄膜材料液は加熱処理等により体積が減少していくが、加熱処理終了後の薄膜材料液の液面が非親和性バンク層と親和性バンク層との境界に位置するよう調整されている。と、非親和性バンク層と親和性バンク層との性質が均衡し薄膜材料液の液面がバンク壁面に垂直になり、全体的に平坦になる。例えば最上層にある非親和性バンク層の

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厚みは500nm以下、それ以外の非親和性バンク層の厚みは100nm以下に設定されている。

【0022】上記第3の課題を解決する発明は、バンクで囲まれた領域に薄膜材料液を充填して形成された薄膜層を積層して構成される表示装置であって、前記バンクは、前記薄膜材料液に対し親和性を示す材料で形成された親和性バンク層と、前記薄膜材料液に対し非親和性を示す材料で形成された非親和性バンク層とが交互に積層され、前記バンクで囲まれる領域にはITO等からなる画素電極が設けられ、薄膜発光素子を形成するための有機半導体材料により前記薄膜層が形成されていることを特徴とする表示装置である。

【0023】上記第4の課題を解決する発明は、バンクで囲まれた領域に薄膜材料液を充填して形成された薄膜層を積層して構成されるカラーフィルタであって、前記バンクは、前記薄膜材料液に対し親和性を示す材料で形成された親和性バンク層と、前記薄膜材料液に対し非親和性を示す材料で形成された非親和性バンク層とが交互に積層され、バンク形成面は透明基板で形成され、前記バンクは画素領域を仕切る仕切部材であって、前記画素に色彩を付与するための着色樹脂材料により前記薄膜層が形成されていることを特徴とするカラーフィルタである。

【0024】なお上記表示装置やカラーフィルタにおいて、親和性バンク層または／および非親和性バンク層は、それぞれ親和性または非親和性を示すように表面処理されたものである。

【0025】

【発明の実施の形態】次に本発明の好適な実施の形態を、図面を参照して説明する。

（実施形態1）本発明の実施形態1はバンクを構成する複数種類の層のうち、一方の層を他方の層のマスクとして利用する薄膜形成方法に関する。図1に本発明の薄膜形成方法によって形成された薄膜積層構造の断面図を示す。この積層構造は多層化した薄膜を使用するあらゆる用途に使用可能である。例えば有機半導体薄膜を利用したEL素子やLED、カラーフィルタ等に使用可能である。図1の積層構造は、薄膜材料液として親水性があるものを使用する場合の構造である。親水性のある薄膜材料液では表面処理された無機材料に親和性が高く有機材料に親和性が低くなる（非親和性）。

【0026】図1に示すように本積層構造は、バンク形成面100にバンク110を設けて構成されている。バンク形成面は、表示装置に使用する薄膜トランジスタ

(TFT: Thin Film Transistor) が形成された駆動基板であってもカラーフィルタに使用する透明基板であっても何でもよい。仕切部材たるバンクで囲まれる領域に流動体を充填して薄膜を形成する目的であればバンク形成面の構造に限定はない。ただし、バンク110の最下層を形成する親和性バンク層111と密着性のよい材料

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であることが望ましい。特に無機材料で構成されていることが後の表面処理で好適な親和性を得るために好ましい。表示装置であれば透明電極であるITOやシリコンなど、カラーフィルタであればガラスや石英等で構成され、親和性バンク層との高い密着性を維持できる。

【0027】バンク110は、親和性バンク層111~11n (nは自然数) および非親和性バンク層121~12nを交互に積層して構成される。親和性バンク層111~11nは、その層に対応する位置の薄膜層131~13nを形成している薄膜材料液と一定の親和性を有するように表面処理されている。親和性バンク層111~11nの材料としてはバンク形成面100や非親和性バンク層121~12nと密着性のよい材料であることが好ましく、その材料が絶縁性、半導体としての性質、導電性のいずれを有していてもよい。例えば親和性バンク層111~11nとして絶縁膜として一般的な、Al、Ta等の金属、シリコン酸化膜(SiO<sub>2</sub>)やシリコン窒化膜(SiN<sub>x</sub>)等を利用することが可能である。各親和性バンク層には同じ材料を用いる必要はない。各親和性バンク層11x (xは任意の自然数) に対応して設けられる薄膜層13xの薄膜材料液と親和性がよい材料であればよく、親和性バンク層の総てを同一の材yろうに統一する必要はない。

【0028】非親和性バンク層121~12nは、その層に対応する位置の薄膜層131~13nを形成している薄膜材料液と非親和性を示するように表面処理されている。非親和性バンク層121~12nの材料としては親和性バンク層111~11nと密着性のよい材料であることが好ましく、その材料が絶縁性、半導体としての性質、導電性のいずれを有していてもよい。例えば非親和性バンク層121~12nとして、ポリイミド、アモルファスシリコン、ポリシリコン、フッ素を有する有機化合物または絶縁有機化合物等を利用することが可能である。各非親和性バンク層には同じ材料を用いる必要はない。表面処理をした場合に各親和性バンク層11x (xは任意の自然数) に対応して設けられる薄膜層13xの薄膜材料液と親和性がよくなる材料であれば材料を変更して積層可能である。例えばカラーフィルタにこの積層構造を適用する場合、最上層12nをブラックマトリクスで構成して遮蔽機能を兼用させてもよい。遮蔽部材として形成するためにはクロム等の金属や酸化物や黒色レジスト材料を用いる。

【0029】各バンク層の厚みは次のように設定する。最下層が親和性バンク層131である場合には親和性バンク層131の厚みd<sub>0</sub>が、この層に対応して形成される薄膜層131の厚みに略同等になるように設定する。その上の層では、非親和性バンク層11x+1と親和性バンク層12xを加算した厚みd<sub>x</sub>がこれらの層に対応して形成される薄膜層13x+1の厚みに略同等になるように設定する。例えば、薄膜層132の厚みは、非親

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和性バンク層121と親和性バンク層112を合計した厚みd<sub>1</sub>に略等しい。薄膜層13nの厚みは、非親和性バンク層12n-1と親和性バンク層11nとを合計した厚みd<sub>n</sub>に略等しい。これらの設定は平坦な薄膜層を形成するために重要である。

【0030】なお上記した積層構造は薄膜材料液が極性基のある分子で構成される場合に適用されるものである。薄膜材料液が極性基のない分子で構成されている場合には、非親和性バンク層と親和性バンク層の材料を入れ替えて使用する。また、薄膜層が一層ごとに極性基のある分子で構成されていたり極性基のない分子で構成されていたりする場合には、各薄膜材料液が充填される位置にある二層のバンク層のうち下層がこの薄膜材料液に対し非親和性を示し上層が親和性を示すようにバンク層の材料を選択すればよい。

【0031】薄膜層131~13nは、それぞれが目的とする性質を備えた材料で構成されている。例えば表示装置に本積層構造を適用する場合、各薄膜層に任意の有機半導体薄膜材料液が充填されて形成される。各薄膜層ごとに、原色を発光する有機半導体薄膜材料液を複数積層したり、必要に応じて正孔輸送層や電子輸送層の材料を充填して積層する。例えばカラーフィルタに本積層構造を適用する場合、各薄膜層に屈折率の異なる樹脂を充填して積層する。このような積層薄膜構造は光学的な干渉フィルターとなり特定波長の光のみが透過され、選択性のよい色彩を提供可能な構成になる。バンクの最上層にはブラックマトリクスを適用してもよい。すなわく酸化クロムや黒色レジスト等を塗布する。この層は非親和性層と兼用であっても非親和性層とは別個に設けられるものでもよい。各薄膜層131~13nの厚みは上述したように、その薄膜層に対応する位置に形成されている非親和性バンク層と親和性バンク層とを合計した厚みに略等しく設定されている。

【0032】(積層構造の作用) 上記バンクの層構造によれば、各層の厚みが均一な薄膜層を積層した装置を提供可能である。バンク110を上記構成に製造してあると、薄膜層の厚みが平坦化される。つまり薄膜材料液を充填していくと、バンクの壁面の親和性によってその壁面に対する薄膜材料液の液面の接触形状が変わる。親和性バンク層との接触面では薄膜材料液が壁面と密着し薄膜の厚みが増加する傾向に、非親和性バンク層との接触面では薄膜材料液がはじかれるため薄膜の厚みが減少する傾向になる。多量に充填された薄膜材料液は加熱処理等により体積が減少していくが、加熱処理終了後の薄膜材料液の液面が非親和性バンク層と親和性バンク層との境界に位置するよう調整されていると、非親和性バンク層と親和性バンク層との性質が均衡し薄膜材料液の液面がバンク壁面に垂直になり、全体的に平坦になるのである。

【0033】この積層構造を使用した装置では薄膜層が

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平坦であることから一定の効果を奏する。各薄膜層の厚みが均一であると、電極間に電流を流して発光型表示素子に形成する場合には、電極間の電流密度が一定になって発光の均一性が向上でき、特定箇所への電流集中を回避できるため信頼性が向上する。また電極間に電圧が印加される素子では薄い箇所電界がかかることが無いので、信頼性が向上し寿命を延ばすことができる。さらに色や明るさが均一化される。またカラーフィルタに適用する場合、色の均一性を向上させ、色抜け等の障害を防止することができる。

【0034】（製造方法）次に本積層構造を得るための薄膜形成方法を、図2および図3の製造工程断面図を参照して説明する。

バンク形成工程（図2（a）～（d））：バンク形成工程は、バンク形成面100に親和性バンク層111～11nおよび非親和性バンク層121～12nを積層してバンク110を形成する工程である。まず親和性バンク層111をバンク形成面100一面に形成する（図2（a））。形成方法は材料によって異なるが、PECVD（Plasma Enhanced Chemical Vapor Deposition）法、CVD（Chemical Vapor Deposition）法、蒸着法、スパッタ法や各種のコート方法（スピスコート、スプレーコード、ロールコート、ダイコート、ディップコート）がある。例えば本実施形態ではSOG（Spin on Glass）によるSiO<sub>2</sub>膜をスピスコート法で形成する。最下層の親和性バンク層111の厚みは薄膜層131の厚みに合わせる。次いでバンク形状に合わせて非親和性バンク層121を形成する（図2（b））。非親和性バンク層の形成方法はまず一面に有機材料を上記方法で形成する。通常のフォトリソグラフィ法を使用する場合にはバンク形状に合わせてマスクを施しレジストを露光・現像・除去し、最後にエッチングしてマスク以外の部分の有機材料を除去する。印刷法を使用する場合は、凹版、平版、凸版等任意の方法でバンク形状に有機材料を直接塗布する。非親和性バンク層121の厚みは後に充填される薄膜材料液をはじく機能を十分奏する程度の厚みにする。ただしこの層に重ねる次の親和性バンク層112と合わせた厚みが薄膜層132に略同等になるような範囲で調整する。次いで非親和性バンク層121をレジストマスクとして無機材料膜をエッチングする（図2

（c））。非親和性バンク層は有機材料でありレジストマスクとして作用可能だからである。次いで再度図2（a）と同様に無機材料としてSOGを一面に塗布する（図2（d））。無機材料の厚みは後に充填される薄膜材料液と密着する機能を十分奏する程度の厚みにする。ただしこの層の下に重ねられている非親和性バンク層121と合わせた厚みが薄膜層132に略同等になるような範囲で調整する。以降は図2（b）～（d）の工程を繰り返しながらバンクを重ねていく。最上層は非親和性バンク層12nが配置されるように積層する。最上層が

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非親和性を有していないとすれば、充填された薄膜材料液がバンク110を乗り越えて流出してしまうからである。

【0035】上記工程により図2（e）に示すようなバンク110とバンクで囲まれた凹部101からなる構造が形成される。この構造により、親和性を示す層と非親和性を示す層が交互に積層された多層構造のバンクが形成される。この後に図3（b）に示すように、凹部101に薄膜材料液を順次充填していく工程に移行すればよい。ただし、ここでは以下に示すようにバンク形成面100とバンク110の各層との薄膜材料液に対する親和性の程度を調整する表面処理を施すことにする。

【0036】表面処理工程（図3（a））：表面処理工程は一定条件下でプラズマ処理を行ってバンク形成面100とバンク110の各層との薄膜材料液に対する親和性を調整する工程である。本発明のプラズマ処理では、導入ガスとしてフッ素を含むガスを用いる。減圧雰囲気下での減圧プラズマ処理であっても大気圧雰囲気下での大気圧プラズマ処理であってもよい。反応ガス中に一定量の酸素が含まれることが好ましい。フッ素系化合物としてはCF<sub>4</sub>、SF<sub>6</sub>、CHF<sub>3</sub>等のハロゲンガス等を用いる。

【0037】薄膜材料液等の任意の流動体に対して表面が濡れやすいや濡れ難いか、すなわち親和性を示すか非親和性を示すかは、材料表面の流動体に対する接触角を測定することで知ることができる。図4に、有機材料と無機材料とをプラズマ処理した際に、フッ素化合物と酸素との混合比によって接触角がどのようにして変わるかを測定した図を示す。接触角は水系インク（水で薄めることのできるインク）に対する接触角である。この図は、フッ素系化合物としてCF<sub>4</sub>を使用し、有機材料としてポリイミド、無機材料としてSiO<sub>2</sub>とITO（Indium-Tin-Oxide）を例示してある。他の材料についてもそれが有機であるか無機であるかに応じて類似する傾向が見られると考えられる。図4に示すように酸素が過剰の雰囲気下では、有機材料、無機材料とも接触角の程度に大きな差異がない。ところがフッ素系化合物が過剰にすると有機材料の接触角が大きくなる（薄膜材料液が親和性である場合、非親和性になる）。これに対し無機材料の接触角の変化は小さい。酸素が反応ガスに含まれると酸素による酸化作用により無機材料および有機材料ともに極性基が発生する。しかしフッ素系化合物が過剰であると有機材料中にフッ素化合物分子が入り込むようになるため、極性基の影響が相対的に少なくなると考えられる。したがってフッ素系化合物が酸素に比べ過剰の条件で制御しながらプラズマ処理することにより、バンク110およびバンク形成面100表面を図4に従って所望の接触角（親和性）に設定することができる。特に図4の最良混合比（CF<sub>4</sub>/CF<sub>4</sub>+O<sub>2</sub>=75%～90%）を使用することは両者の接触角の差が最大とする

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ために好ましい。ただし、重要な点は、ポリイミドとSOGやITOとの間における接触角の差が大きく設定することにより、この目的を達成するためには図4によればCF<sub>4</sub>が約70%以上あれば十分であると考えられる。例えば親和性バンク層表面が薄膜材料液に対し接触角が30度以下になるように表面処理される。また非親和性バンク層表面が薄膜材料液に対し接触角が40度以上になるように表面処理される。

【0038】以上の事実より本実施形態ではフッ素系化合物を導入ガスとして一定の割合で酸素が混合されるように減圧プラズマ処理または大気圧プラズマ処理を行う。例えば容量結合型のプラズマ処理では上記ガスを反応室に流し一方の電極上にバンク形成面100を有する基板を載置し、電源から電界を加える。反応室へのエネルギーの加え方には公知の方法、例えば直流法、高周波法、誘導結合形、容量結合形、マイクロ波法、電界と磁界とを併に加える方法等を種々に適用可能である。

【0039】例えばバンク形成面100（凹部101の底面）をITO等の透明電極、親和性バンク層をSiO<sub>2</sub>、非親和性バンク層をポリイミドで形成した場合、上記表面処理により、薄膜材料液130に対する親和度はバンク形成面>親和性バンク層>非親和性バンク層という順番になるように表面処理される。

【0040】薄膜形成工程（図3（b）～（d））：薄膜形成工程はバンク110で囲まれた凹部101に薄膜材料液を順次充填して薄膜層を積層していく工程である。薄膜材料液130としては、表示装置に適用する場合、有機半導体材料、正孔輸送層として正孔供給元素をドーピングした材料、電子輸送層として電子供給元素をドーピングした材料等を使用する。カラーフィルタに適用する場合には、着色樹脂等を適用する。

【0041】各薄膜材料液を充填する量は、当該薄膜層に対応する位置に形成されている層の厚みにより調整する。最下層の薄膜層131では、加熱処理により薄膜材料液から溶媒成分が蒸発した後の厚みが親和性バンク層111と略同等になるような量に調整される（図3

（b）の破線）。それより上の薄膜層132～13nでは、加熱処理により薄膜材料液から溶媒成分が蒸発した後の厚みが、対応する位置に設けられている非親和性バンク層12xと親和性バンク層11x+1との合わせた厚みに略同等になるように調整される（図3（c）

（d））。

【0042】薄膜材料液を充填する方法としてはインクジェット方式によることが好ましい。インクジェット方式によれば任意の位置に任意の量で流動体を充填することができ、家庭用プリンタに使用されるような小型の装置で充填が可能だからである。インクジェット方式で薄膜材料液を充填したら、薄膜材料液を加熱して溶媒成分を除去する。インクジェット式記録ヘッドから吐出させるには通常粘度が数p c以下であることを要する。この

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ため最終的な必要な薄膜層の厚みに比べて吐出量は多い。吐出直後では、薄膜材料液は最終的な厚みより上に配置されている親和性バンク層と接する。加熱処理により溶媒成分が蒸発し体積が減少するに連れて、薄膜材料液はバンク壁面に液面が引かれながらもその液面を下げてくる。この液面が非親和性バンク層にかかるると薄膜材料液がはじかれるため、薄膜材料液と壁面との接触点が一段下の親和性バンク層に移る。このようにして液面が段階的に下がっていき最終的な薄膜層の厚み近くまで薄膜材料液の体積が減少すると、薄膜材料液の液面と壁面との接触点はその薄膜材料液と接しているバンク層の中で最も下に位置する親和性バンク層とその直上の非親和性バンク層との境界にまで移動する。薄膜材料液の充填量は、加熱処理後における薄膜材料液の体積が、その薄膜材料液を充填した中で最も下に位置する非親和性バンク層および親和性バンク層とを合計した高さまでの嵩と略等しく設定されている。このため、最も下に位置する親和性バンク層とその直上の非親和性バンク層との境界に液面が移動した後は、それ以上液面が下がることのない。体積減少により薄膜材料液の中央部の厚みが徐々に下がり、バンク壁面との接触部分から中央部までの総ての部分において等しい厚みになった段階で、薄膜層が固形化され完成するのである。

【0043】例えば、最下層の薄膜層131では、図3（b）に示すようにインクジェット式記録ヘッド102から薄膜材料液130をバンク110で囲まれた凹部101に破線の位置まで吐出する。そして加熱処理をして平坦な薄膜層131にする。その上の薄膜層132では、図3（c）に示すようにインクジェット式記録ヘッド102から薄膜材料液130を薄膜層131上に破線の位置まで吐出する。そして加熱処理をして平坦な薄膜層132にする。これらの処理を薄膜層13nが形成されるまで繰り返す。

【0044】なおインクジェット方式としてはピエゾジェット方式でも熱による気泡発生による吐出する方法であってもよい。ピエゾジェット方式では圧力室にノズルと圧電体素子とが備えられて構成されている。圧力室に流動体が充填されている圧電体素子に電圧を印加すると圧力室に体積変化が生じノズルから流動体の液滴が吐出される。気泡発生により吐出する方式では、ノズルに通ずる圧力室に発熱体が設けられている。発熱体を発熱させてノズル近辺の流動体を沸騰させ気泡を発生させてその体積膨張により流動体を吐出するものである。加熱による流動体の変質が無い点でピエゾジェット方式が好ましい。

【0045】上記したように本実施形態1によれば、各薄膜層を平坦に形成することができる。またフッ素系化合物に酸素が混入している条件でプラズマ処理を行うことにより、薄膜材料液に対し有機材料でできたバンク表面の非親和性と、無機材料でできたバンク表面およびバ

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ンク形成面の親和性を調整することができる。しかも図4に示すような特性にしたがって親和性の度合いを示す接触角を容易に設定できる。すなわち、バンク自体はバンク形成面との高い密着性を保ちながら、親和性制御のために従来のように多数の工程を経ることなくバンクとバンク形成面との親和性を確実に制御することができる。これにより、薄膜材料液がバンクを超えて流れ出ることを防止し、歩留まりを向上させ、製造コストを減少させることができる。

【0046】(実施形態2) 本発明の実施形態2は上記実施形態と異なる方法でバンクを積層するものである。図5に本実施形態の製造工程断面図を示す。本実施形態は上記実施形態1と同様に、バンク形成面に任意の形状でバンクを設け、バンクで仕切られた領域に所定の流動体を充填するようなあらゆる用途に適用されるものである。例えば有機半導体薄膜素子を利用した表示素子で有機半導体材料を画素領域に充填する場合やカラーフィルタで着色樹脂を画素領域に充填する場合に適用可能である。

【0047】下層膜形成工程(図5(a)~(c)):

下層膜形成工程は、バンク形成面100に親和性バンク層111を形成する工程である。まず上記実施形態1と同様の方法により無機材料を塗布する(図5

(a))。次いで無機材料層上にバンク形状に合わせてマスク140を設ける(図5(b))。次いで無機材料層をエッチングし、マスク140が載置された領域を残して無機材料を除去する(図5(c))。エッチング方法は、材料の性質に合わせて選択する。SiO<sub>2</sub>等の無機材料の場合、ドライエッチングの他にフッ酸(HF)等のエッチング液を使用したウェットエッチングが適用できる。以上で最下層の親和性バンク層111が形成される。次に上記実施形態と同様の方法により有機材料を塗布する(図5(d))。次いで有機材料層上にバンク形状に合わせてマスク142を設ける(図5(e))。次いで有機材料層をエッチングし、マスク141が載置された領域を残して有機材料を除去する(図5

(f))。エッチング方法は、材料の性質に合わせて選択する。ポリイミド等の有機材料の場合、ドライエッチングの他に、(NMP(N-メチルピロリドン))等のエッチング液を使用したウェットエッチングが適用できる。以上で非親和性バンク層121が形成される。本実施形態では上記実施形態1のように非親和性バンク層をマスクとして親和性バンク層をエッチングするものではなく各上層を独立してエッチング可能なため、親和性バンク層におけるバンク形状と非親和性バンク層におけるバンク形状とを異ならせることが可能である。例えば、下層から上層にいくに従ってバンクの幅を狭くしていき、階段形状や擬似的なテーパー形状に形成することができる。このようにバンクを形成すれば、薄膜層となる薄膜材料液の充填が容易とすることができ、またバンクを

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乗り越えて配線パターンを形成する場合にその配線の断線を防止することができる。このバンク下層の形状を適当なものを選ぶことにより、薄膜層を好適に設けることができるようになる。以上の工程(図5(a)~(f))を必要な積層回数(例えばn回)繰り返して、バンク110が図5(g)のように形成される。表面処理工程および薄膜層形成工程については上記実施形態1と同様なので説明を省略する。

【0048】上記したように本実施形態2によれば、実施形態1と同様の効果を奏する他、バンクの各層の形状を異ならせることができるので、適用デバイスに応じて最適な薄膜層の形状を設定できる。

【0049】

【実施例】上記実施形態を適用した実施例の層構造を示す。図6は本発明をカラーフィルタに適用した実施例の層構造断面図である。図6に示すように、本カラーフィルタは、基板200に仕切部材210を例えば平面からみて格子状に形成し、仕切部材210で囲まれる画素領域201に着色樹脂231~233を充填して構成されている。基板200は本発明のバンク形成面に相当し、着色樹脂と密着性がよい透明な材料、ガラスや石英、樹脂等で構成されている。仕切部材210は本発明のバンクに相当し、親和性バンク層として樹脂層(または無機絶縁膜層)211、非親和性バンク層としてブラックマトリクス層221が形成されている。樹脂層(または絶縁膜層)211は樹脂をバンク形状に整形して構成される。ブラックマトリクス層221は無機材料やカーボンを含む有機絶縁材料を塗布して構成されている。着色樹脂層231(赤)、232(緑)、233(青)は本発明の薄膜層に相当し、画素領域201ごとに赤、緑、青等の原色の染料を混ぜた樹脂を充填して構成されている。

【0050】上記構成によれば、樹脂層(または絶縁膜層)211が着色樹脂と親和性があるように表面処理されブラックマトリクス層221が着色樹脂と非親和性を示すように表面加工されている。このためインクジェット方式により着色樹脂を充填し加熱処理すると着色樹脂層231~233が平坦に形成される。このため、明るさや色にむらが生じない画像表示を行うことができる。

【0051】図7は本発明を表示装置の有機半導体発光素子に適用した実施例の層構造断面図である。図7に示すように、本有機半導体発光素子は、駆動基板300に透明電極341さらにバンク310を形成し、バンク310で囲まれた凹部301に有機半導体層331を形成して構成されている。全体を覆って金属電極351が形成されている。駆動基板300はTFT、配線、絶縁膜等が多層に積層され、透明電極341と金属電極351間に電圧を印加可能に構成されている。透明電極341はITO等を0.05μm~0.2μm程度積層して構成され、有機半導体層331からの光および金属電極3-



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51による反射光を透過可能に構成されている。バンク310は下層311と上層321とにより構成されている。下層311は有機半導体材料に親和性のある無機材料で構成され、CVD法やスパッタ法または各種コート法等で形成される酸化シリコンや窒化シリコン等により構成される。上層321は有機半導体材料に非親和性を示す有機材料で構成され、ポリイミド、アモルファスシリコン、ポリシリコン、フッ素を有する有機化合物または絶縁有機化合物等により構成される。有機半導体層331は、電界の印加により発光する材料、例えばポリフェニレンビニレン(PPV)等、公知の材料を0.05  $\mu\text{m}$ ~0.2  $\mu\text{m}$ 程度積層して構成される。金属電極351はアルミニウムリチウム(Al-Li)を0.1  $\mu\text{m}$ ~1.0  $\mu\text{m}$ 程度積層して構成される。

【0052】上記構成によれば、下層311が有機半導体層331と親和性があるように表面処理され上層321が有機半導体層331と非親和性を示すように表面加工されているので、インクジェット方式で有機半導体材料を充填し加熱処理すると、有機半導体層331が平坦に形成される。このため、明るさや色にむらや色抜けが生じない画像表示が行える。また電極短絡を防止し、表示装置全体の信頼性を向上させ、寿命を延ばすことができる。

【0053】図8は本発明を表示装置の有機半導体発光素子に適用した他の実施例の層構造断面図である。図8に示すように、本有機半導体発光素子は、駆動基板400に透明電極441さらにバンク410を形成し、バンク410で囲まれた凹部401に正孔輸送層431、有機半導体層432を積層して構成されている。全体を覆って金属電極451が形成されている。駆動基板400、透明電極441、有機半導体層432、金属電極451間に関しては上記図7の実施例と同様である。バンク410は親和性層411、412と非親和性層421、422とを交互に積層して構成されている。親和性層411は正孔輸送材料や有機半導体材料に親和性のある無機材料で構成され、CVD法やスパッタ法または各種コート法等で形成される酸化シリコンや窒化シリコン等により構成される。非親和性層421は有機半導体材料に非親和性を示す有機材料で構成され、ポリイミドまたはアモルファスシリコン、ポリシリコン、フッ素を有する有機化合物または絶縁有機化合物等により構成される。正孔輸送層431は正孔を陽極である透明電極441から有機半導体層432まで運ぶことが可能な材料、例えば正孔供給元素を混入させたITOにより構成されている。

【0054】上記構成によれば、親和性層411が正孔輸送層431と親和性があるように表面処理され、親和性層412が有機半導体層432と親和性があるように表面処理されている。また非親和性層421が正孔輸送層431や有機半導体層432と非親和性を示すように

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表面加工されている。このため正孔輸送層431および有機半導体層432をインクジェット方式により充填し加熱処理すると、それぞれが平坦に形成される。このため、明るさや色にむらや色抜けが生じない画像表示が行える。また電極短絡を防止し、表示装置全体の信頼性を向上させ、寿命を延ばすことができる。

【0055】なおカラーフィルタや有機電界発光素子の構造は上記に限らず種々に変更可能である。例えば有機電界発光素子ではさらに電子輸送層や他の有機半導体層を積層させてもよい。

【0056】(その他の変形例) 本発明は上記実施形態に限定されることはなく、本発明の趣旨の範囲で種々に変更して適用することが可能である。親和性材料や非親和性材料およびそれらを用いたバンクの形成方法は上記によらず種々に変形可能である。本発明の主旨は親和性の程度の異なる層を交互に配置することにより、薄膜層を歪み無く形成する点にある。例えば厚膜化が可能なバンク形成用の材料でバンクを形成する他、親和性を示す材料や非親和性を示す材料をバンク表面に塗布することで本発明のバンクを形成してもよい。例えば、ジエチレングリコールメチルエチルエーテル( $\text{C}_2\text{H}_5\text{OCH}_2\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_3$ )や2-パーフルオロオクチルエチルアクリレート( $\text{FCF}_2)_8\text{CH}_2\text{CH}_2\text{OOCH}=\text{CH}_2$ )は、それ自体で極性基分子を有する薄膜材料液に対して非親和性を示す。

【0057】また、上記表面処理はプラズマ処理に限られるものではなく、図4に示すように同一の表面処理条件下で異なる親和性に加工できる表面処理方法であれば適用が可能である。本発明の主旨は表面加工により親和性を調整する点にあるからである。したがって親和性を設定する材料は無機材料と有機材料との間に限られるものではなく、特定の材料間において図4に示す親和性の特性を示すものであれば、その特定材料間において本発明の表面処理を適用可能である。

【0058】また、上記バンクは親和性のある材料と非親和性を示す材料を積層するにと留まらない。例えば、本発明の構成は、単一の部材で構成した後、薄膜材料液に対し親和性を示す領域と非親和性を示す領域とが交互になるように形成することでも達成できる。例えばバンク材料を親和性材料で構成し、縞状に非親和性材料を塗布することが考えられる。非親和性材料には上記具体例の他、パラフィン等が挙げられる。またバンク材料を非親和性材料で構成し縞状に紫外線照射して親和性のある領域を作ったり、縞状に脱チャージして電荷を利用して親和性材料を塗布したりが考えられる。さらにバンク材料全体に金属薄膜を形成し、親和性のある置換基を持った硫黄化合物と非親和性を示す置換基を持った硫黄化合物とに下層から順に浸漬していけば、単分子集合化膜により縞状に親和性領域と非親和性領域が形成できる。

【0059】

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【発明の効果】本発明の薄膜形成方法によれば、異なる材料でバンクを積層することで、形成される薄膜層を歪み無く形成することができる。これによりデバイスの性能や信頼性を大幅に向上させることができる。また本発明の薄膜形成方法によれば、表面処理を一定条件下で行うことにより、親和性制御のために多数の工程を経ることなく薄膜を多層化可能に親和性を制御することができる。これにより、親和性制御に要するコストを削減し、均一な膜厚で薄膜の多層化を可能とすることができる。本発明の表示装置によれば、多層化を可能とする薄膜形成方法によって多層化されているので、均一な厚みの薄膜層を積層可能である。これにより、明るさや色にむらや色抜けが生じない画像表示が行える。また電極短絡を防止し、信頼性を向上させ、寿命を延ばすことができる。本発明のカラーフィルタによれば、多層化を可能とする薄膜形成方法によって多層化されているので、均一な厚みの薄膜層を積層可能である。これにより、明るさや色にむらが生じない画像表示を行うことができる。

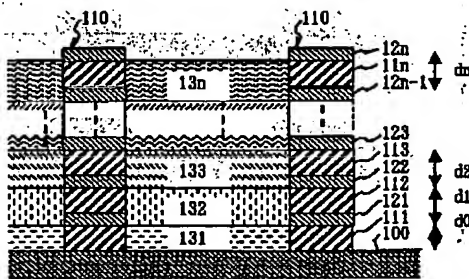
【図面の簡単な説明】

【図1】本発明の実施形態1に係る薄膜積層構造の断面図である。

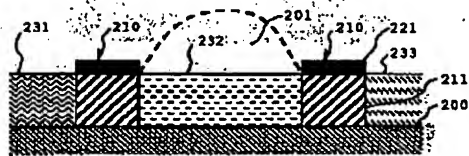
【図2】本発明の実施形態1に係る薄膜形成方法の製造工程断面図である。

【図3】本発明の実施形態1に係る薄膜形成方法の製造工程断面図、(続き)である。

【図1】



【図6】



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【図4】本発明の表面処理の原理に係るフッ素系化合物と酸素との混合比と接触角との関係を説明する特性図である。

【図5】本発明の実施形態2に係る薄膜形成方法の製造工程断面図である。

【図6】本発明をカラーフィルタに適用した実施例の断面図である。

【図7】本発明を表示装置の有機半導体発光素子に適用した実施例の断面図である。

10 【図8】本発明を表示装置の有機半導体発光素子に適用した他の実施例の断面図である。

【図9】従来のバンク形成における問題点の説明図である。

【図10】従来のバンク形成における問題点の説明図である。

【符号の説明】

100、200、300、400 バンク形成面（基板）

101、201、301、401 凹部

20 110、210、310、410 バンク

111～11n、11x 親和性バンク層

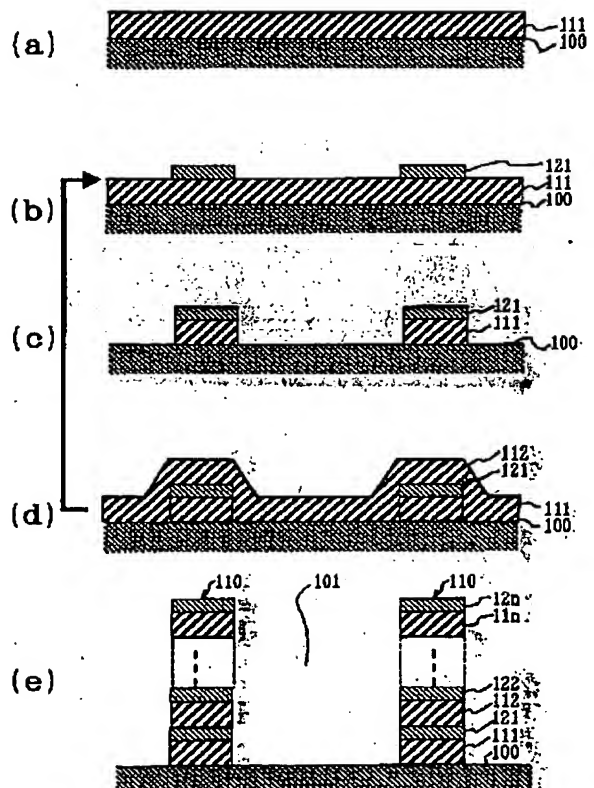
121～12n、12x 非親和性バンク層

130 薄膜材料液

131～13n、13x 薄膜層

102 インクジェット式記録ヘッド

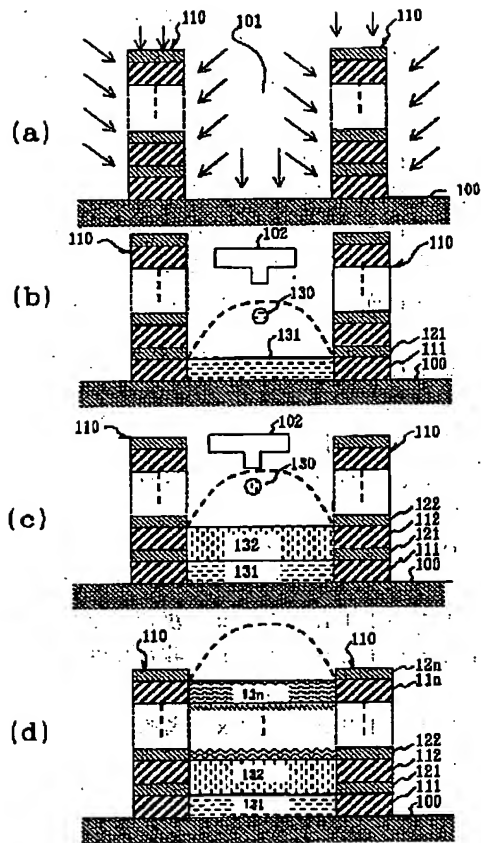
【図2】



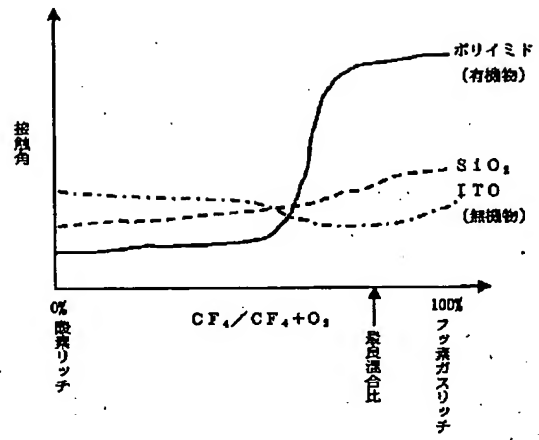


(12)

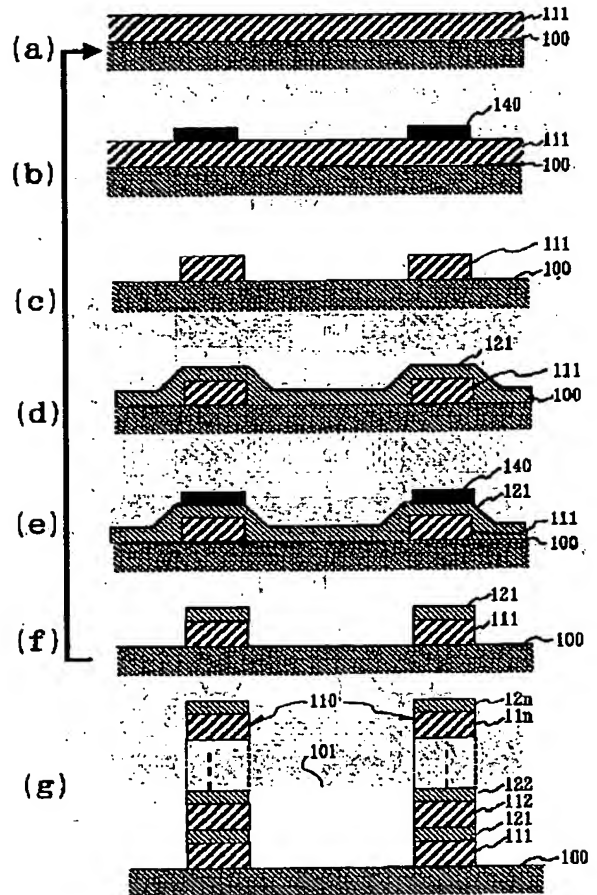
【図3】



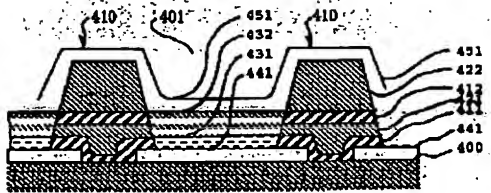
【図4】



【図5】

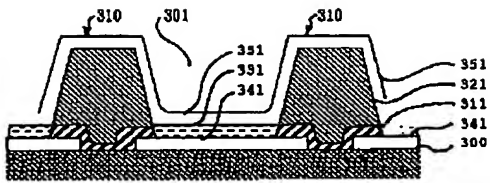


【図8】

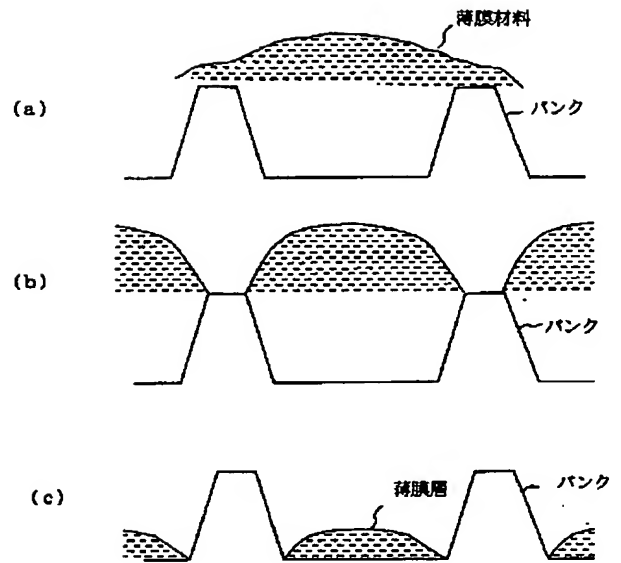


(13)

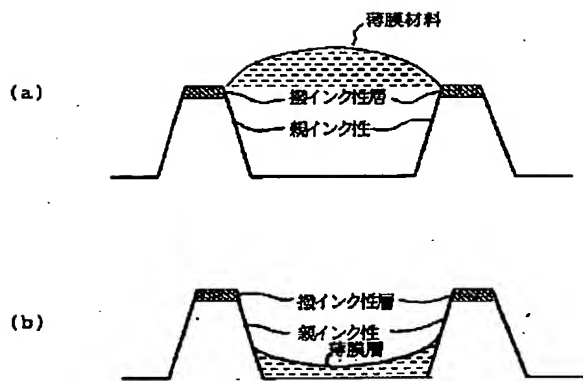
【図7】



【図9】



【図10】



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